DOCUMENT RESUME

ED 343 581	IR 015 539
AUTHOR	Carey, Doris, Ed.; And Others
TITLE	Technology and Teacher Education Annual 1992. Proceedings of the Annual Conference on Technology and Teacher Education (3rd, Houston, Texas, March 12-15, 1992).
INSTITUTION	Association for the Advancement of Computing in Education, Charlottesville, VA.
REPORT NO	ISBN-1-880094-03-7
PUB DATE	92
NOTE	668p.; For 1991 annual, see IR 015 440.
AVAILABLE FROM	Association for the Advancement of Computing in Education, P.O. Box 2966, Charlottesville, VA 22902 ($35.00).
PUB TYPE	Collected Works - Conference Proceedings (021) -- Reports - Research/Technical (143)
EDRS PRICE	MF03/PC27 Plus Postage.
DESCRIPTORS	Computer Simulation; *Educational Research; Educational Theories; Elementary Secondary Education; Graduate Study; Higher Education; Hypermedia; *Information Technology; Instructional Design; Mathematics Instruction; *Multimedia Instruction; *Preservice Teacher Education; Science Instruction; *Teacher Education; *Telecommunications

ABSTRACT

The 147 papers in this collection represent the cutting edge in the field of information technology for teacher education. The keynote address, presented by Thomas F. Ryan of Illinois State University, is entitled "Using Technology: A College of Education's Experience." Following that is an invited paper presented by Brent Robinson of the University of Cambridge, England, entitled "The English National Curriculum and the Information Technology Curriculum for Teacher Education." Subsequent papers are divided into 13 categories: (1) Hypermedia (5 papers); (2) Inservice and Graduate Education (6 papers); (3) Integrating Technology into Methods Classes (9 papers); (4) Issues (16 papers); (5) Instructional Technology and Design Issues (6 papers); (6) Technology Projects and Their Management (9 papers); (7) Multimedia (16 papers); (8) Preservice Teacher Education (17 papers); (9) Research (11 papers); (10) Mathematics and Science (8 papers); (11) Telecommunications (25 papers); (12) Theory (9 papers); and (13) Simulations (5 papers). Almost all of the papers provide their own abstracts and bibliographies. (DB)

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Society for Technology and Teacher Education

Technology and Teacher Education Annual 1992

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Technology
and
Teacher Education
Annual
—1992—

Published for the Society for Technology and Teacher Education
by
Association for the Advancement of Computing in Education
Post Office Box 2966
Charlottesville, VA 22902 USA
(804) 973-3987; FAX: (804) 978-7449;
E-mail: AACE@VIRGINIA.EDU

ISBN 1-880094-03-7

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Published by Association for the Advancement of Computing in Education (AACE)
P.O. Box 2966, Charlottesville, Virginia 22902, USA

Printed in the USA

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PREFACE

The State of The Art in Technology and Teacher Education

The papers in this Annual were presented at the Third Technology and Teacher Education Conference in Houston, Texas. The conference, held March 12-15, 1992, is a major meeting for teacher educators interested and involved in the use of information technology for teacher education. The papers in this Annual represent the cutting edge in the field.

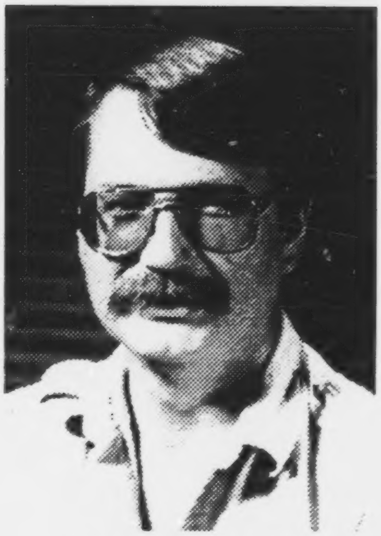
Two things stand out about this issue of the Technology and Teacher Education Annual. First, it is the largest thus far. Compared to the 1991 conference, twice as many proposals were submitted, and the number of papers accepted was almost double last year's total. The sheer quantity of work is one indication that information technology is on its way to becoming an integral part of teacher education. We aren't there yet, but we can point to outstanding work in many areas — methods courses, undergraduate and graduate programs, science and mathematics teacher education, research and development, multimedia and hypermedia, simulations, telecommunications — in virtually every area of teacher education. During this decade, the last of this century, technology-using teacher educators will bring information technology out of isolation in the educational computing course and integrate it into the entire range of teacher education. Many of the innovative, cutting edge projects described in this publication will be routine, expected activities by the turn of the century.

That brings us to another aspect of the papers in this Annual. They represent a significant increase in quality as well as quantity. The field is maturing and this year, for the first time, the Society for Technology and Teacher Education recognized outstanding papers presented at the conference. The Section Editors and General Editors nominated a number of papers for awards, and the Awards Committee of the Society evaluated the papers. Considering the high quality of this year's papers narrowing the field to the fourteen chosen was quite difficult. Many others could also have been recognized.

Quality and quantity are apparent in this Annual, but as we ship this issue to the printer another factor comes to mind. That is the dedication and hard work of many, many people. Few conferences of this size review and edit papers submitted by presenters and then design and lay out a publication that is available when participants arrive at the conference. After three years, the many people involved can tell you why they don't. It is very hard to do when everyone involved is a volunteer. General Editors Doris and Regan Carey, for example, spend hundreds of hours on the Annual after Section Editors have worked on the papers in their sections. The labor begins, however, with the Section Editors. They receive papers from presenters and work under a tight deadline to revise, edit and shape them into a strong section for the Annual. All these people are volunteers who do the work because they think it is important to the field. Although the Society thanks them for their work, they are themselves, in reality, the heart of the Society. When you have the opportunity please convey your appreciation to all the editors and let them know you recognize and appreciate their work.

Finally, this is the first edition of the Annual published after the Society for Technology and Teacher Education became a division of the Association for the Advancement of Computing in Education. The affiliation with AACE strengthens STATE and provides us with a supportive organizational home. AACE is the official publisher of this edition of the Annual (as well as the 1991 edition). AACE has also made arrangements with the ERIC system to place the Annual on microfiche and to abstract papers in the Annual so that manual and computer searches for publications on technology and teacher education will locate papers published in the Annual. That expands considerably the potential audience for these papers and benefits the field by making current knowledge accessible.

Jerry Willis
Dee Anna Willis
Co-Directors
Technology and Teacher
Education Conference



Regan Carey

Doris Carey

The Society for Technology and Teacher Education wishes to extend its heartfelt thanks to Doris and Regan Carey for their dedicated work on the 1992 edition of the Technology and Teacher Education Annual. Their "above and beyond" efforts, along with the hard work of all the Section Editors, produced another excellent Annual.

Jerry W. Willis, President
Society for Technology and Teacher Education

Keynote Address: Using Technology: A College Of Education's Experience

Thomas F. Ryan
Illinois State University

Abstract

The College of Education, Illinois State University has developed a unique capacity to explore the use of technology. A detailed description of current capacity and use of the platform, as well as the processes by which it was developed, is presented. A discussion of strategies used to accumulate the fiscal and human resource base is included. Special attention is given to the creation of the ISU/IBM partnership.

I have been asked to share the Illinois State University College of Education's experience in exploring the use of technology in teacher education. What follows is very much a report of work in progress. It describes an exploration being carried out by teachers searching for answers to these questions: What can we do to improve our programs to prepare teachers? What role can technology play in the process?

Our story is presented in the manner of a case study. That is, events are presented in roughly chronological order. However, ours is very much a non-linear environment. Illinois State University and its College of Education have embarked on substantial changes within the past four years. The arrival of new leadership within the University provided the direction for change; technology has played a significant role in shaping these changes.

Our story unfolds in three parts. Part I describes the current status of technology within the College of Education (COE). Part II details the evolution of COE computing capacity. Part III provides a glimpse of work in progress and plans for the future.

Historical Perspective

At the start it may be useful to indicate who we are and why our story may be of interest. Illinois State Normal University was established in 1857 as the first publicly funded university in Illinois. From its inception, teacher education was a primary focus of programs and services. Emerging as a multi-purpose institution in the middle sixties the University matched excellence in teacher education with quality programs in many other academic disciplines such as chemistry, accounting, and theater.

In 1991, the University enrollment stood at 23,000 students. The COE enrolled approximately 2,100 undergraduates and 640 graduate students. In addition, more than 1,000 practicing teachers and administrators participate in professional development activities sponsored by the COE.

The Department of Curriculum and Instruction enrolls approximately 1,400 undergraduate students majoring in Early Childhood, Elementary, and Junior High/Middle School Education, 175 graduate students, and an additional 900 undergraduate students majoring in disciplines housed in other colleges who are seeking secondary certification. The Department of Specialized Educational Development serves 700 undergraduate students majoring in Special Education and approximately 285 graduate students in Special Education, Reading, and Counselor Education. Educational Administration and Foundations is a graduate department enrolling approximately 190 students in master's, certificate of advanced studies, and doctoral programs.

The COE also operates the University Laboratory Schools. Defined by law as a public school system operated by the University, the schools are organized in two buildings and enroll a total of 1,130 students. The Metcalf Elementary School serves 500 students ranging from those enrolled in an infant program through grade eight. University High School has an enrollment of 530 students in grades 9-12. Approximately 225 of the lab school students are individuals with low incidence disabilities.

The COE employs approximately 354 faculty and staff. Three academic departments employ 120 faculty in 83 FTE faculty positions. The Laboratory Schools employ an additional 150 individuals. The FY92 composite COE budget was approximately 12 million dollars, including $7.7 million in general revenue appropriated to the University, $2.3 million in general school aid which follows laboratory school students from their home schools, and $2.9 million in grants and contracts.

As our research and service functions have expanded, we have not lost sight of the fact that we are primarily teachers. Over 90% of our resources are assigned to instruction. As teachers, we believe it is our responsibility to explore new technologies of teaching and learning. Our institutional experience as well as the challenges we face are similar to that of many others across the nation who are teachers searching for ways to improve practice. We hope that we may learn together.

Part I - Computing In The College of Education: Status 1992

COE students in 72 different courses are required to work with computers. This includes 14 courses in which a computing requirement was added this year. Although actual time commitments vary from course to course, the total clock hours of in-class microcomputer instruction is 1,295 hours. The growth of instructional use is chronicled in Figure 1. This does not include the newly installed AS/400 capacity which will be integrated into course activities during the next academic year. Lab usage has shown a similar pattern of growth. During FY91, 18,741 individuals used the COE college-wide lab. The IBM demonstration network was used by 3,497 individuals.

Faculty and staff support paralleled instructional installations. Today, 73% of the COE and Lab School faculty (more than 80% of tenure-line faculty) have a personal computer assigned to them.

The COE capacity has been developed through a series of individual efforts, institutional initiatives, and corporate partnerships. They will be discussed in subsequent sections of this report. Their combined effect has been to create a unique capacity within the COE. An overview of that capacity is shown in Figures 1 and 2.

College of Education: First Steps 1970 - 1985

The Pyramid System, a computer based auto-tutorial system to support secondary education, was introduced in the COE in the early seventies. Students accessed video sequences of classroom activities through terminals to complete course requirements. Courses operated on an entirely open schedule using specified product outcomes and performance criteria. Faculty served as facilitators/ mentors. The system eventually deteriorated due to inadequate support for necessary maintenance.

A Microcomputer Laboratory using Radio Shack TRS-80 machines was introduced in the late seventies. As is the case with most significant changes in organizations, the introduction of technology in the COE was the work of a small group of faculty members who had an idea and the energy to pursue it. In 1977, a member of the Department of Curriculum and Instruction approached the local manager of the Radio Shack outlet with a request for support. As a result, over 25 TRS-80s were donated to the college. Those machines, configured as a laboratory, formed the basis of computing in the COE for several years.

Adaptive Technology was introduced through the Department of Specialized Educational Development which began building a multi-purpose computer laboratory in 1980. As proposed the lab was to serve as an instructional facility for undergraduate students, a software evaluation center for teachers in schools throughout the region, and a demonstration center for adaptive technology. In addition, the facility was to be used to provide keyboarding instruction for students enrolled in the Thomas Metcalf Laboratory School. The original plan called for the installation of thirty microcomputers equally divided among Apple IIe, Macintosh, and IBM or IBM compatible systems along with appropriate adaptive equipment, and a substantial software inventory. Special education training grants have enabled the department to make progress toward its goal. The lab's current configuration was achieved using funds derived through grants, alumni donations, the Provost's Equipment Fund, and department equipment budgets.

Figure 1: Laboratories

Three (3) COE Computing Labs:

Department of Educational Administration and Foundations Lab

Equipment: 25 IBM XT and compatibles Token Ring networked to AS/400 and ISUnet.

Primary Use: Teaching future school administrators research and statistics use and school management applications.

Department of Specialized Educational Development Lab

Equipment: 20+ Apple Computer (IIe, IIc, IIgs) - Several Macintosh computers.

Primary Use: Adaptive peripherals, supporting special education instruction, service, and research.

College of Education College-Wide Lab

Equipment: 20 IBM PS/2 Model 25 computers with a Novell Token Ring Network and connections to the AS/400 and ISUnet, 25 Zenith XTs, and several IBM, Macintosh, Apple IIe, and Apple IIgs computers.

Primary Use: Teaching future teachers the use of computers as tools for instruction, software evaluation, and as an open lab for word processing.

Secondary Use: Public relations and service site for COE available free of charge to the public—awareness presentations, seminars, and workshops on classroom applications, software, and networking for practitioners and other interested parties.

Four Laboratory School Computing Labs:

University High School

Equipment: 25 Apple IIe systems

Primary Use: All freshman and sophomore English and writing classes.

University High School

Equipment: 25 Zenith XT clone computers

Primary Use: Business, industrial technology (CAD), computer classes.

Metcalf Elementary School

Equipment: 6 Macintosh SE computers

Primary Use: Keyboarding, word processing, music.

Metcalf Elementary School

Equipment: 10 Apple IIe systems

Primary Use: Keyboarding, word processing, math, and other academic areas.

Figure 2: Special Use Facilities

Faculty/Staff Computing Facility

Equipment: 1 IBM, 1 Macintosh, with laser printers

Primary Use: Faculty/staff only, quality printing, text conversion, Mac-to-IBM conversion, and disk size conversion, access to special software.

Faculty Interactive Multimedia Development Laboratory

Equipment: 5 IBM PS/2 Model 70, 2 IBM PS/2 Model 80, touch window systems, state of the-art peripherals, and development software tools including ten authoring systems.

Primary Use: Development of interactive instruction and presentation materials.

Post-Production Video Editing Facility

Equipment: Industrial quality VCRs, video and audio mixers, video toaster.

Primary Use: Final editing of videotapes for instruction, demonstration, and information dissemination.

Mini-Computer Network

Equipment: 1 AS/400 Model B35, 1 AS/400 Model D20, 1 AS/400 Model D02.

Primary Use: Comprehensive Information Management for Schools (CIMS), a system used to train future school administrators about school management software. Also used as the primary management software for Laboratory Schools and selected College areas. Demonstration configuration for Distributed Student Management System (DSMS).

Three (3) IBM Grant K-12 Classroom Teaching Networks

Equipment: 33 IBM PS/2 Model 25 Computers Networked Into 3 Labs of 10 machines with a file server and 3 PSInet workstations. Located in Metcalf Elementary, University High School, and DeGarmo Hall.

Primary Use: Supporting teacher education program.

College-wide efforts focused on the introduction of technology-supported clerical services. In 1980, a typing pool using Lanier word processing equipment was established and operated until 1985. Each department office was provided a TRS-80 to support administrative functions. However, collegiate efforts were not well organized. There were no established structures or procedures to coordinate needs analysis and equipment acquisition, allocation, maintenance, and evaluation.

Part II - Computing in a Context of Accelerating Change: 1985 - 1991

By the middle eighties, computing across the University had taken on a "topsy-like" quality. Pessimists saw it as out of control, while optimists viewed it as creative exploration. The predictable response was to get organized. In November, 1985, the Provost directed the Office of Academic Computing to issue a call for each college to provide a detailed assessment of current activity and projected academic computing equipment and service needs. The call was accompanied by a notice that, "future funding for college computing will be based in part on the plan submitted."[1] To assist colleges, a set of Guiding Principles was provided and are quoted here to give a sense of institutional direction.

> ACADEMIC COMPUTING PLAN GUIDELINES
> GUIDING PRINCIPLES
> OCTOBER 10, 1985
>
> In the development of the academic plan for computing, consider the following as guiding principles. These statements represent bench marks which have been enumerated in various University documents. Their presence should serve to point a direction but by no means are they meant to limit the scope of the planning process.
>
> 1. All students, faculty and administrators have access to computing resources at minimal additional cost.
> 2. One terminal is available for each 20 students.
> 3. Faculty members have easy access to terminals.
> 4. All terminals can communicate with each other and the mainframe.
> 5. The capability exists for the free flow of information from one terminal to another.
> 6. A microcomputer laboratory is available to provide technical assistance and software coordination.
> 7. Faculty members have sufficient time available to assist in the development of software for computer integrated instruction, computer managed instruction, and computer testing development.[2]

Clearly, the emphasis at the time was on mainframe computing and cost containment. Within one year the emphasis began to shift. The introduction to the 1986 revision of the Academic Computer Plan signaled the beginning of the micro age at ISU.

Technology is a tremendous force for creating change in society. In particular, computer technology has revolutionized many facets of contemporary society. Computers have led to significant advances in medicine, engineering, data processing and education. In many environments, a computer on a desk is as common as a telephone. The computer presents opportunities for improved communications, increased productivity, and enhancements to the teaching and research processes. Illinois State University has made the commitment to enhance the computer literacy and ability of its faculty, staff, and students.[3]

The revised plan established two major goals: "First, all faculty and students will have the opportunity to become computer literate. Second, instruction and research will be enhanced through the increased use of computers."[4] The Provost expanded his commitment to support college plans by allocating $620,000 per year to the enterprise. It was suggested that each college internally reallocate an additional amount equal to 25% of the equipment request to purchase software and another 25% for personnel services needed to support the systems. To underscore his commitment, the Provost awarded 17 faculty members Instructional Development Program Grants to promote instructional use of technology.

The University initiative had been anticipated by the COE. In 1985, the College of Education Academic Computing Committee had been appointed. The committee was charged with responsibility for the development of a five-year renewable plan. A survey instrument was used to collect data regarding current faculty use and attitudes. Hearings were held during which each organizational unit within the college presented its view of needs, opportunities, and preferred approaches. The Committee reviewed the data and testimony, and published its report. The Committee found that the use of technology had grown steadily through the late seventies. That growth had occurred as opportunities and resources became available. Although there was no plan, a base had been established.

Adopting the label ***Computer Intensive College*** encountered at the 1986 EDUCOM meeting, the committee published a statement of intent:

The College of Education has encouraged and continues to encourage and strongly support the establishment of computer literacy among its students, faculty, and staff. In order to facilitate the establishment of computer literacy, the College of Education is promoting the development of a ***Computer Intensive College***. The concept of a ***Computer Intensive College*** offers an insightful and challenging opportunity in response to the national demand for computer literate individuals in our society today.[5]

Three goals were established to guide the development of the ***Computer Intensive College:***

1. To facilitate the establishment of an initial level of computer literacy among students, faculty, and staff within the College of Education; (1-2 Year Goal)
2. To enhance the establishment of initial computer literacy, and to promote advanced computer literacy and applications, as appropriate, through the acquisition of specific computer hardware, software, and consultation services; (1-5 Year Goal)
3. To continue to support research and development efforts within the College of Education regarding innovative techniques and applications of computer technology and to implement new computer technologies as appropriate. (On-Going Goal)[6]

Specific objectives were developed to guide the initiative.

- To develop a Computer Intensive College, where each student, faculty member, and staff member has immediate access to a microcomputer networked to the College of Education;
- To develop a procedure for the utilization of telecommunications which would call for a creative and flexible delivery of instruction for an aggressive off-campus course schedule;
- To computerize office procedures with shared peripherals, file management, and software applications;
- To increase the use of computing in instructional areas;
- To make greater use of electronic mail, conferencing systems, and public networking systems;
- To acquire a sufficient quantity of microcomputers that will ensure that microcomputers are readily accessible to all faculty and administrators;
- To develop a continual and systematic method for upgrading and replacement of microcomputer hardware, software, and cabling to buildings;
- To develop policies and procedures and to acquire equipment necessary to facilitate modem communication from home to College of Education for faculty members;
- To provide continued and enhanced microcomputer support and inservice and to ensure that the College of Education computer initiatives are reflective of technological advancements;
- To locate microcomputers in laboratory school classrooms which will facilitate computerized curriculum instruction for laboratory school students and allow for hands-on computer application in clinical experiences for teacher-education students.[7]

Implementation was separated into four phases to be carried out over an eight-year period. Phase One focused on building capacity through staff development and equipment acquisition. In this phase the emphasis was on establishing laboratory facilities. Phase Two was designated as the time for coordination of effort, standardization of systems, and expansion of applications in instruction and research. The committee recognized the need to establish support systems and to call upon external consultants to help design specifications and installations. Attention was also directed to the need to explore local area networking on a limited basis. In Phase Three the plan called for a shift in emphasis to expanded activity based upon expanded capacity. Objectives called for the college to "strongly support research and development in the area of curriculum software design for large networked situations."[8] An expectation for a "funding commitment for the purpose of implementing large-scale microcomputer hardware and software purchase, large-scale network installation, building renovation, maintenance and support . . ."[9] Phase Four activities would continue to develop capacity, expand activity, and both maintain and upgrade equipment.

New Leadership = Accelerated Change and New Direction

Thomas P. Wallace took office as the fourteenth President of Illinois State University in August, 1988. His arrival had been preceded in June by the arrival of a new Dean of Education. Within the following eighteen months, new deans of the College of Fine Arts, the College of Business, Graduate Studies, and Undergraduate Studies were appointed. New Directors of Computer Services and Telecommunications and of Academic Computing were also named. During that same period, new Vice-Presidents of Business and Finance, Institutional Advancement, and Student Services joined the administrative team. Early on, the president asked each dean or unit administrator to prepare a vision statement describing their unit's prospects in 2007, the sesquicentennial anniversary of the University.

In May, 1989, the dean's vision statement was published as the College of Education Strategic Planning Document. The purpose of the document was to establish direction. The vision statement was followed within a year by a Three-Year Plan of Operation, which provided detailed information regarding college programs, served as a budget document, and provided the basis for evaluation of college productivity. The College of Education statement focused on the rapidly changing context of schooling in the United States.

The strategic mission of the College of Education is to influence expectations, attitudes, and policies that affect education at all levels. The College contributes directly to the improvement of educational experiences available to citizens throughout Illinois, nationally, and internationally through an active involvement in social, economic, political, and professional issues.[10]

Influencing Schooling became the Strategic Theme used as a rubric under which informed judgments regarding the impact that existing programs, services, and proposed initiatives might be expected to have upon schools and the schooling process. Results have shaped resource allocation and become major assessment criteria for personnel and programs within the College. Faculty and staff have been asked to evaluate their activities, particularly research and service efforts, in light of their potential to affect what happens in schoolhouses across Illinois and the nation.

Six operational themes were developed to provide specific direction for program development and service delivery. Theme #5, Technology to Improve Teaching & Learning, provided a focal point for the study of the use of electronic technology. The theme was developed as follows:

Projections for the 21st Century emphasize the increasing pace of change in all aspects of life. Contemplating the effects of anticipated change, educators emphasize the development of critical-thinking, problem-solving skills, and the prerequisite ability to manipulate data rapidly as keys to personal success. Advances in technology offer many avenues to improve the design, delivery, and management of educational experiences as well as the assessment techniques available to determine the effects of those experiences. The College of Education intends to exert leadership in the application of technology to improve education.[11]

The operational theme refocused attention on a process that had begun almost a decade earlier as computing technology was introduced in the College.

Maximizing University Support

The Provost's program to support the use of technology provided the COE a total of $283,000 during the period from 1985 to 1991. Allocations were based on requests detailed in annual college computer plans prepared by the College Computing Committee. Special requests to support the installation of the interactive technology laboratory and the purchase of a twenty station IBM PS2 Model 25 laboratory provided an additional $73,000.

Presidential support for strategic initiatives provided resources needed to implement strategic planning initiatives. As a follow-up to the submission of College Strategic Planning documents, each dean was invited to submit requests for funding to support one or more initiatives. Those requests were submitted to the President of the University in February, 1990. The College of Education requests included a request for support to purchase an IBM AS/400 minicomputer and appropriate software, and to employ an individual to manage the system.

The request specified four COE functions that would be enhanced through the use of the minicomputer. First, the College would use the AS/400 as a tool to administer its two laboratory schools. The second use would be to support the preparation of school administrators. The request described a technology-based element of the administrator preparation program that would involve observation of the lab school application as a model and the ability to conduct simulation exercises using real-time data purged of identifying factors. A third function focused on the potential as a research tool to support faculty and advanced graduate students. Finally, a fourth function projected the AS/400 as a central node in a communications network linking the College of Education with professional colleagues throughout Illinois. President Wallace approved the request with an equipment allocation of $180,000 and support for a permanent new position designated AS/400 systems manager. An additional $60,000 in College and Laboratory School funds completed the installation and provided staff training.

The University Office of Computing and Telecommunications completed three projects between 1989 and 1991 that influenced the development of technology within the College. Initially, a fiber-optic backbone linking the entire campus was installed. ISUnet provided dramatically new opportunities for data transmission and information management. ISUnet provided immediate support for the COE technology initiative. In a second project, the University's mainframe was upgraded through the installation of a Hitachi HDS AS/EX 80 and the addition of a RS/6000 Model 530. The third project was the installation of a new digital phone system.

One measure of the influence of the COE initiative within the university is found in the priority assigned for connection to the fiber optic backbone. Although COE facilities were situated in four distinct installation zones, each was assigned priority standing and placed in Phase One of the connection and activation plan. Thus, as of December 1991, all COE facilities were linked through connections to ISUnet.

Building External Partnerships

The COE technology team identified three characteristics necessary to respond effectively to the challenge to establish collaborative relationships with business and industry. The first is a vision of what the college wishes to become. The vision must be easily communicated and clearly understood by both parties. The second is an understanding that collaborative relationships require commitments and contributions from both sides. University personnel too often assume that the contributions will come exclusively from the business partner. Finally, colleges must be willing to commit to a results orientation. Traditional input orientation does not match up very well with corporate interest in return on investment. Both parties must have a clear understanding of the outcomes that are expected to result from the collaboration.

The COE vision had been set out in planning documents. The university and the COE had made substantial commitments in equipment and personnel resources to begin to achieve the vision. And, the COE leadership recognized that it would be necessary to showcase contributions while maintaining a posture of constructive critic.

The ISU/IBM Partnership established in 1990 dramatically accelerated the implementation of the COE technology initiative. Without this corporate assistance, the College would not have been able to pursue the exploration of the use of technology in teacher education. The partnership developed through three distinct stages. The first stage which began in 1989 consisted of an early exploration of the potential effect a substantial commitment to an IBM platform might have for COE programs. Stage two focused on the successful application to become one of the 144 colleges of education participating in the IBM Teacher Education grant program. Stage three involved the expansion of the role of the minicomputers in COE programs.

Stage one of the partnership began early in 1989. The COE Coordinator of Technology Transfer began negotiations to qualify the College for the "Try It and Buy It" promotion, through which IBM offered to loan a school district a laboratory consisting of twenty Model 25s, a Model 80 file server and a substantial inventory of K-12 instructional software as a prelude to purchase. Labs were to be on loan for six months, at which time the school district would either purchase or relinquish the equipment.

With the assistance of the Regional Superintendent of Schools and leaning heavily on the fact that the College included the K-12 Laboratory Schools, we qualified for the program. The Model 25 Lab was installed in a dual purpose facility within the College in October, 1989. The lab became an immediate success as an instructional tool for teacher education classes and as a center for hands-on demonstrations for teachers and students from schools throughout the region. In the initial six-month period, instructional use and demonstrations reached an average of almost 300 participants per month. Thus, although the College was not in a position to complete the purchase of the "lab," the loan period was extended for several months until resources, including a special grant from the Provost, could be accumulated. During that time, usage continued to grow, eventually leveling off at 400 per month. The success of the laboratory installation had established our confidence in our relationship with IBM education and marketing representatives. That confidence was affirmed when marketing representatives informed us of IBM's intention to sponsor a grant program to colleges of education to improve their programs through the use of computer technology.

Stage two of the partnership began when we decided to use the announcement of the grant program as an opportunity to revise the COE Technology Theme. We began with the belief that every school teacher and administrator ought to have at their fingertips the information necessary for them to achieve excellence . That information would range from student records to research on effective teaching, and reports of the experiences of other practitioners. A proposal that described an integrated network of computing facilities that would support the college mission of teaching, research and service was prepared.

The proposal detailed three specific installations. The first was a distributed computing installation. Initially, we proposed to use two college classrooms and two Laboratory School classrooms. The second element in the proposal called for the installation of an AS/400 to support the administrator preparation program, improve administration of the college and laboratory schools, and serve as a communications link to schools throughout Illinois. The third part of the proposal presented a design for an interactive technology laboratory to provide an environment in which faculty and students might explore the limits of the technology envelope.

Early in the fall we learned that some doubt as to the wisdom of entering a partnership with our College might exist within the corporate hierarchy. The concern reportedly focused on the fact that the COE had not developed a strong reputation in the area of instructional technology. We did not, for example, offer either degree or degree concentrations in the field. To counter that reported perception, and with the help of our regional marketing staff, we arranged to host a site visit by personnel involved in the grant program. That visit occurred in October. At that time, we learned that the intention was to provide one ten-station laboratory and a complete inventory of software to approximately 100 colleges of education. Clearly, our vision encompassed a more comprehensive installation than the program was designed to support. Nevertheless, we decided to submit our comprehensive proposal. That is, we submitted a proposal including two laboratories and accompanying software, a minicomputer, and hardware necessary to provide the base for an Interactive Multimedia Technology Laboratory.

During December, 1989, IBM representatives informed us of their interest in forming a partnership and to indicate that our proposal was beyond the scope of the grant program. Our response underscored the fact that we had presented our vision of the capacity requisite to a college of education of the future, a college we hoped to create. We expressed our hope that IBM would be willing to help us begin the processs of creation. A series of conversations led to an agreement that established the ISU/IBM partnership. The COE received three laboratories, each consisting of ten PS/2 Model 25s and one Model 80 file server. In addition, the grant included three PS/2 Model 25s to function as PSInet terminals and three site licenses for the complete inventory of K-12 software.

To help establish the Interactive Multimedia Development Laboratory, IBM provided five PS/2 Model 70s, one PS/2 Model 50zs, one Touch Screen Display, and one laserdisc player. Additional support from the Provost and the use of funds raised through alumni contributions enabled the COE to implement the original design.

The third stage of the ISU/IBM partnership focused on the expansion of the use of the AS/400 Model B35 purchased by the COE in 1990. Early in 1991, corporate representatives approached us to discuss ways in which our experience using the AS/400 in administration, instruction, research, and service functions might be shared with both public school practitioners and teacher educators across the nation. Discussions continued through the spring, at which time they began to focus on a collaborative effort involving ISU, and two other universities. The initial focus of the project would be to develop instructional modules to support the use of the Comprehensive Information Management for Schools (CIMS).

As the conversations developed through the summer, the IBM State Education Consultant suggested that project outcomes might be significantly enhanced through the use of ISU COE Laboratory Schools which might serve as a site to explore the Distributed Student Management System which was then in the final stages of development. Faculty from the Department of Educational Administration and the administrative staff of the Laboratory Schools began to develop a revised plan. On December 16, 1991, we were informed that our proposal had been accepted and that we would receive two additional minicomputers, one AS/400 D02, one AS/400 D20, and three site licenses for the inventory of CIMS modules, including the Distributed Student Management System (DSMS). The equipment was installed in January 1992, establishing a model for demonstration and development. At the time of installation, the COE was one of three sites in the country using the DSMS.

Part III - Computing in the College of Education: 1992 and Beyond

We had equipped our College with an exceptional array of technology. We now faced the challenge of using what we had acquired. Our first priority was to establish a pattern of faculty use. A second priority was to become a "beta site" for research and development projects. A third was to develop a range of services to schools and other organizations throughout the region. We were also interested in establishing an income stream within our facilities.

Faculty involvement in the use of the COE new capacity was stimulated through a competition supervised by the College Computing Committee. Faculty were invited to submit proposals to use specific installations for projects designed to enhance instruction. Proposals accepted for implementation would be supported with requisite staff training as well as access to equipment. Thirteen proposals involving 44 individuals were approved. Projects were, for the most part, focused on the development of classroom applications for either teacher education courses or Lab School classrooms. Several projects were designed to develop a particular scholarly interest.

For example, four faculty members from the Educational Administration Program proposed to develop interactive modules to assist practicing school administrators to meet requirements for continued certification. Another group proposed to develop simulations using Lab School student data purged of individual identification. A faculty member interested in Native American history proposed to develop a *Linkway* presentation for classroom use.

World Scan was the first opportunity for us to serve as a "beta-site." The project was a joint venture between IBM, Cable News Network, and Modern Talking Pictures to bring world events into the classroom. CNN would broadcast a fifteen-minute news summary through a secure network to participating schools at 2:45 a.m. The program would be received in the school and would become a part of the school's archives. Shortly thereafter, a four-page "lesson plan" developed by Modern Talking Pictures would be disseminated through IBMnet and captured on a local terminal. A PS/2 Model 65 installed in a specially designed kiosk would be used to integrate news broadcasts with archival materials available in laserdisc, videotape, and compact disc formats. Integrated programs would be generated by students using a new piece of software called the *Multimedia Presentation Generator* (MPG). MPG is a software program that can be used to easily enhance *Linkway* folders with full motion video from laser disc, video tape, or video camera. Although the joint venture was eventually abandoned, MPG emerged as a viable commercial product that is currently available.

Experience as a "beta-site" was a new adventure for COE technology support personnel. As we explored the use of materials we had been asked to test, we soon found ourselves to be substantially ahead of the corporate Help Lines. Most often our inquiries about next steps were met with, "We don't know how to do that," or "You can't do that with the equipment you are using." When confronted by the fact that we were indeed "doing it," support personnel asked us to provide them with documentation for their use.

In addition to the opportunity to assist in the development of MPG (and to have the use of that product) as a beta-site, the COE has also been given the opportunity to use experimental models of video cassette recorders, touch screen displays, authoring systems, and software applications.

Teaching and Learning with Computers (TLC) is the label used by IBM to designate the use of computers as tools to support learning within the classroom environment. The fact that IBM had selected this approach, which mirrored the philosophy of the COE, led to another joint project. In March 1991, two Lab School teachers attended TLC training sessions in Atlanta. Subsequently, those teachers led a TLC workshop on our campus. The June workshop involved 24 IBM Education Industry Specialists from five states.

The TLC workshop provides an excellent example of the mutual benefits that accrue to the ISU/IBM partnership. The COE Lab School teachers made substantial modifications in the TLC training that they had received in Atlanta. Modifications were based on their experience using computers as a tool for instruction. The corporate interest in training was achieved while the COE's responsibility to provide constructive criticism was also fulfilled. Both parties benefitted.

Project Homeroom presented a different opportunity. In 1990, representatives of Ameritech, Illinois Bell Telephone Company, and IBM met to discuss a multifaceted project to integrate computer technology in the instructional program of schools located in and around Chicago. The concept was to develop five discrete but interrelated projects placing 500 IBM Model PS/2 microcomputers in the homes of students attending five different schools. In each site, different networking configurations would be used to link students to information sources necessary to achieve learning objectives. In addition to a wide array of databases, students would be networked with each other and with their teachers. Interested schools were invited to prepare proposals describing how they would use the technology to support their curriculum. Proposals dealt with many aspects of the curriculum, from integrated social science and language instruction, to science and language arts, to second language instruction. The project was initiated in the summer of 1991.

The COE became involved as the evaluator for three of the Project Homeroom sites. As in the case of the projects, the evaluation has taken on new dimensions. The evaluation is in the form of a case study. Evaluation products will be videotapes that describe the project from its inception through implementation to completion. In order to carry out the project, the COE has established a post-production videotape editing facility. Thus, the Homeroom evaluation contract has contributed directly to the continued development of our capacity.

Read My Lips is one of the most sophisticated applications developed within the Interactive Multimedia Technology Development Lab. Read My Lips was designed by a faculty member from the department of Applied Computer Science in cooperation with a fourth-grade Lab School teacher supported by the Interactive Technology Lab Manager. Designed to assist students with speech and hearing disabilities to develop lip reading skills, the application is an integrated Audio Visual Connection product. Students view full motion pictures of an individual mouthing words, give their response, and then check their response by viewing additional pictures of the model. The application has been selected as a finalist in the Johns Hopkins National Search for Computing to Assist Persons with Disabilities.

Nibbles and Bytes, the COE computing newsletter, was established in 1987 to provide information regarding the status of computing within the COE, to inform faculty and staff of developments in computer technology and applications in education, and to publicize the efforts of the College to explore the use of technology in teacher education. Each issue includes a number of standard features. Techno-Jargon Corner helps users understand the language of technology. Spotlight On Software presents brief reviews of new acquisitions. Technology Transfer focuses on new systems, equipment, and applications. In Dear John News the lab manager shares activities and opportunities for faculty and staff. Recent issues have carried stories on topics ranging from Token Ring Networking, to AS/400 Applications, to Using Microcomputers in Fourth Grade Classrooms. The newsletter is published six to eight times each year and distributed to COE faculty and staff and to approximately 400 professional colleagues in schools and universities across the nation.

The Future at ISU

In the future instruction will remain a primary focus of development as the COE works to insure that each new teacher and administrator understands the role of technology as a tool to support professional performance. During the next two years, the COE hopes to establish two classrooms of the future to support teacher education programs. To support instruction, academic advising within the COE will be restructured to provide on-line access to students seeking information regarding their program or individual standing.

Research focused on the effects of the use of technology in all aspects of schooling will grow, with particular emphasis being placed upon collaborative field-based action research with practitioner colleagues.

Service applications will grow dramatically during the next five years as the COE builds its role as a coordinating partner in an information network linking educators throughout Illinois and the Midwest. Demonstration and software evaluation will continue to be a major service activity to schools throughout the area. We will work to develop the service function in order to create an income stream necessary to maintain and to continue to develop our capacity.

Within the University, the COE has formed an alliance with the College of Fine Arts to provide computer support service to faculty throughout the institution. This is an important move due to the fact that the College of Fine Arts has developed an extensive capacity based on an Apple platform.

The COE Technology Team: Prerequisite to Success

Perhaps the most interesting aspect of the Illinois State University COE success is found in the people who make up the Technology Team. Each COE faculty and staff member has contributed in distinct ways. Walt Pierce, Dent Rhodes and Michael Lorber, who provided early leadership, continue to pursue their interests in computing. New faculty members such as Jeff Hecht, the *Project Homeroom* evaluator, whose background included an undergraduate degree in computer science and recent experience with a computer information network linking schools state-wide in California, expanded our potential. New users have become our most important clients. However, one group has accepted particular responsibility for current and future achievement: the Technology Team. They are the prerequisite to success:

- Coordinator of Technology Transfer, Mrs. Marygrace Surma, is a former special education teacher who became interested in computer technology while working as a coordinator of clinical experiences in 1985. Mrs. Surma provides current information regarding equipment and software applications, coordinates acquisition, carries out installation, provides training, and represents the COE to the university computing community.
- Interactive Multimedia Development Lab Manager, Mr. Rafael Gomez, came to ISU in 1989 as a graduate student in curriculum. Mr. Gomez brought with him extensive experience in video broadcast production and rapidly developing expertise in microcomputer based interactive technology. He is the individual who stretches the envelope.
- Dr. Joaquin Vila, Assistant Professor of Applied Computer Sciences, joined the ISU faculty in 1989. Interest in Artificial Intelligence and computer applications to assist persons with disabilities led him to the COE where we immediately made him a member of our team. Dr. Vila developed Read My Lips in collaboration with Faculty Associate Kathy Ahlers.
- AS/400 Systems Manager Sue Hardwig joined the COE in October 1991. Mrs. Hardwig, a former business education teacher, is a partner in an independent consulting firm that provides support service to schools using IBM systems.
- Computer Lab Managers: College-wide Lab - Mr. John Tarter (co-editor of Nibbles and Bytes); Educational Administration Lab - Dr. Patricia Klass (Chair of the College Computing Committee); and Special Education Lab - Ms. Julie Caplinger assisted by student workers, provide demonstrations and support for lab users.

The Technology Team is a blend of teachers and technologists for whom the excitement of discovering new ways to make the equipment perform is exceeded only by their enthusiasm for seeing the creative ideas of others materialize. They are our most important resource.

The platform described in this report provides a base for the faculty and students of the College of Education to explore the future. It is a platform which permits each to become a true knowledge navigator. The exploration will continue.

Endnotes

1 Academic Computing Plan Guidelines, "Guiding Principles, ISU Office of Academic Computing", October, 1985.
2 Ibid.
3 Ibid.
4 Ibid.
5 Internal Memorandum, College Plan for Academic Computing, College of Education, November, 1985.
6 Ibid.
7 Ibid.
8 Ibid.
9 Ibid.
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Invited Paper from the United Kingdom Association of Information Technology in Teacher Education:

The English National Curriculum and the Information Technology Curriculum for Teacher Education

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Abstract

England is currently experiencing unprecedented government legislation aimed at reforming the national education system at several levels. This has direct and indirect implications for the technological education offered to student teachers. This paper outlines existing legislation aimed at teacher educators in England and discusses the ways in which information technology is currently delivered in initial teacher education. The views of teacher educators on core and permeation models of delivery are presented. The paper then discusses the National Curriculum that has been imposed on schools and the ways within it in which schools have been called upon to include technology. Some examples from different curricular areas are given together with examples from the specific information technology curriculum. The point is made that information technology is expected to permeate all subjects within the National Curriculum. The resultant skills that are now required of teachers are identified. The paper then considers the implications of technology in the National Curriculum for teacher education suggesting that a permeation model reflecting school practice is appropriate. The problems with a permeation model are presented and teacher education at Cambridge University is given as an example of the model in practice. The paper draws attention to the problems schools are having in implementing technology and what this means for teacher education in technology that is school based. The paper concludes with an overview of the most recent legislative changes to teacher education forcing it to become more school based. It discusses the problems this will create for the technological training of new teachers and suggests some of the ways in which teacher educators and classroom teachers will have to work together to ensure that information technology can be put to really effective use in English schools. England is currently experiencing an unprecedented degree of legislation aimed at reforming its national education system. This is taking place alongside the advent, rapid development, and uptake of computers in our society so it is not surprising that the legislation is integrally interwoven with the role of information technology in education. The change affects most levels of the system and most of its functions either directly or indirectly.

Since 1984 there have been statutory regulations governing initial teacher education. In 1989, following a Government enquiry into the place of information technology in initial teacher education, these regulations were revised and strengthened with the place of information technology becoming explicit:

"...all courses should contain compulsory and clearly identifiable elements which enable students to make effective use of information technology (IT) in the classroom and provide a sound basis for their subsequent development in this field. They should be trained to be able to:

1) make confident use of a range of software packages and information technology devices appropriate to their subject specialism and age range;
2) review critically the relevance of software packages and information technology devices appropriate to their subject specialism and age range and judge the potential value of these in the classroom;
3) make constructive use of information technology in their teaching and in particular prepare and put into effect schemes of work incorporating appropriate uses of information technology;
4) evaluate the ways in which the use of information technology changes the nature of teaching and learning" (Department of Education and Science, 1989a, Para 6.6).

The question then for British educators is not whether or not information technology should be introduced into initial teacher education but how it should support and affect that teacher education.

English training institutions have adopted a variety of responses. The delivery of information technology ranges from discrete core courses to a model of total permeation in which the technology is integrated into the subject specific and general education of students. Many institutions adopt a mixture of both approaches.

There are, of course, arguments for and against each approach. At a nationally convened seminar of teacher educators (Whiteman, 1990), it was suggested that the discrete information technology course could offer a rigorous instruction by expert information technology staff; guaranteed coverage of requisite skills, knowledge and understanding; ease of timetabling, control and monitoring; and an efficient use of staff and other resources. It was argued that the discrete course frees up time in the subject specific areas of the timetable but at the same time can gain benefit from cross curricular participation. It also gains a profile from being easily identifiable by students. On the other hand, the teacher educators felt there was a danger that discrete core courses could become isolated courses. They fail to meet the perceived needs of students whose interests are firmly focussed on their own teaching subjects—at least at the beginning of their courses. Discrete courses fail to meet the needs of staff; they discourage the development of IT expertise by other instructional staff, and the discrete course may not meet the curriculum needs of each subject. They are delivered by technology staff and are technology led—sometimes without any significant attention to the role of information technology in teaching and learning. Finally, but importantly, discrete courses were claimed to offer a poor model of practice.

The same group of teacher educators thought an approach involving information technology permeation throughout training courses offered a better, curriculum led model. Here the technology is developed in context and integrated with other learning. This was seen as a flexible, less disruptive and non-threatening approach that develops confidence in all staff as well as their engagement with the technology as resources are available. A permeated delivery was thought to sharpen assessment demands and encourage the development of contemporary assessment methods such as student profiling. Again, though, this model of information technology delivery was seen to have its drawbacks. A permeated approach requires commitment from all staff, considerable activity in staff development and a willingness to share expertise. For technical support staff there is a high work load as greater numbers of less experienced staff become involved in teaching IT and as resources are geographically distributed. For teaching and administrative staff, a permeated model was thought to be problematic to organise with monitoring, assessment and coordination particularly difficult. A picture of the total student experience is hard to obtain.

In 1986 Her Majesty's Inspectors of Schools visited 22 representative institutions offering initial teacher education. They found that attempts to move to full permeation of information technology across all parts of student training had, in some cases, been premature and met with only limited success. Most institutions had gone back to a discrete core course supplemented by some permeation (Her Majesty's Inspectorate, 1988).

Since the visits by the inspectors, the position of information technology in schools has changed radically with considerable significance for the way in which information technology is presented in initial teacher education. In 1988, a compulsory National Curriculum was introduced for all state schools in England and Wales. (Scotland and Northern Ireland have separate educational systems.) Statutory Orders have been produced for each subject in the curriculum defining the programme of study to be delivered. Each Order also contains attainment targets for the subject and pupils will be tested at ages 7, 11, 14, and 16 to see which levels of attainment they have achieved. In all subjects, information technology plays important roles within the statutory individual programmes of study and the attainment targets. For example, in the Order for English (Department of Education and Science, 1989b), children between the ages of 5 and 7 should be faced with reading material that reflects the real world— explicitly this should include computer printouts and visually displayed information.

They should be able to produce copies of work drafted on a computer, and be encouraged to incorporate the print-out in other work, including displays. In History (Department of Education and Science,1991), pupils should have opportunities to use a range of historical sources, including computer based materials. It is suggested they use a database in learning how to ask questions and to select and organise historical information and to use desk top publishing to present their results. In the learning and using of a modern foreign language, pupils should have regular opportunities to use computers. The programme of study (National Curriculum Council, 1991) suggests language games, problem-solving, information retrieval, word processing, drafting and redrafting, desktop publishing and communicating via electronic mail.

In each subject of the National Curriculum, information technology is seen as a vehicle for learning. Its function is to enhance learning opportunities. But within the National Curriculum, information technology is also presented as a subject of study in its own right. Pupils should be able to use information technology to communicate and handle information; design, develop, explore and evaluate models of real or imaginary situations; and measure and control physical variables and movement. They should be able to make informed judgements about the application and importance of information technology, and its effect on the quality of life (Department of Education and Science, 1990). The Order for Technology contains a complete programme of study for information technology together with 10 levels of attainment. It is worth giving some examples to demonstrate what teachers must now be prepared to teach and children to learn.

Within the first two years of schooling, all children should be taught that information technology can be used to help plan and organise ideas in written and graphical form; how to give instructions to electronic devices; and how to store, select and analyse information using software. By the final two years of compulsory schooling children should be taught to work together using discussion, explanation and negotiation to improve the quality of the information presented using information technology; to use information technology to improve efficiency and to support new ways of working; to select software appropriate for a particular task or application; to design and implement an information technology-based system for use by others; to review and discuss their use of information technology and to consider applications in the outside world, and the impact on daily life, including environmental, ethical, moral and social issues. In addition, more able students will be taught to define the information required, the purposes for which it is needed, and how it will be analysed and to take these into account in designing ways of collecting and organising the information in a database; to analyse systems to be modelled using information technology, make choices in designing, implementing and testing them, and justify the methods they have used.

The significant point here is that information technology is not to be taught as a discrete subject. Pupils should acquire information technology capability through their study of other subjects.

> "...our aim is to ensure that all pupils have a firm foundation of general information technology skills which can be developed through their work in subjects across the curriculum..."

> ...our aim is to ensure that all pupils have a firm foundation of general information technology skills which can be developed through their work in subjects across the curriculum... (Department of Education and Science, 1989c, Para 3.9).

In order for this to be achieved, not only individual teacher expertise but whole school coordination is required.

Schools will have to ensure that a coherent and consistent policy for information technology exists within the curriculum, so that pupils' experiences are complementary and not unduly repetitive, and that the information technology knowledge, skills, understandings and values gained are related to the broader principles and processes of information technology (Department of Education and Science, 1988, Para 3.3).

Each school has therefore drawn up a plan indicating the subjects in which information technology is to be developed and the aspects of information technology that are to be delivered in those subjects. According to the National Curriculum Council (1990), teachers in all subjects are now responsible for:

- using information technology to enhance learning;
- developing each pupil's information technology capability in accordance with school policy;
- ensuring that each pupil has access to information technology resources;
- monitoring and evaluating pupils' experiences;
- determining the next stage in each pupil's use of information technology, and ensuring continuity and rigour;
- contributing to each pupil's record of development.

With this total permeation model expected within schools, it seems sensible to replicate at least some aspects of it in initial teacher education institutions so that students become familiar with a cross curricular approach to information technology. At Cambridge we have been moving towards a permeation model though it began in advance of the introduction of the National Curriculum.

We were fortunate in that the subject lecturers very early on realised the potential of information technology to enhance the quality of teaching and learning and were eager to implement it. Our information technology policy reflects this attitude. It states that all teaching staff are expected to have a positive but discriminating attitude towards information technology and to demonstrate appropriate use of information technology within their curriculum subject and advise students accordingly. Students are therefore presented with a view of information technology as an integral part of their training, no matter what their subject or age phase.

From their early visits to teacher education institutions, Her Majesty's Inspectors (Whiteman, 1990) considered that effective permeation of information technology requires:

- clearly specified objectives for each curricular area so that reaching targets can be checked;
- mapping to show that students are offered a wide range of experiences and when;
- monitoring to see that it is happening;
- auditing to assess the total value of the separate experiences.

Further, effective permeation depends upon staff having the expertise to deliver what is required of them.

At Cambridge, the course operates in the following way. There is a meeting each term between the information technology lecturer and each subject course leader. At this meeting, the information technology delivery in the previous term is analysed against stated aims, new needs are identified and the following term planned. Most information technology activities are planned to arise within the curriculum subject work. In English, for example, word processing is introduced through a series of activities designed to illuminate the nature of the writing process and the teaching of language awareness. In biology, students first use information technology for image capture and desktop publishing because of the course leader's belief in the highly visual nature of the subject. In Modern Languages, electronic communication is featured early in the course so that students can explore the possibilities for gathering authentic language material from other countries.

Once the exact nature and sequence of the activities have been agreed upon, a term programme is drawn up indicating scheduled activities together with periods during which students will be expected to work independently on technology related activities. We make considerable use of self study materials devised to complement lecturers' activities and to take into consideration the diversity of student expertise. The materials also serve as a model of teaching with which we wish our students to become familiar. The self study is complemented by the provision of regular access to technical support if individual students require it. Members of the team of technical support staff are also scheduled at the term meeting to support subject lecturers in the delivery of the formally taught technology elements of their courses.

An important feature of the meeting each term is a discussion of new training needs for staff. The Lecturer in information technology will bring new technological developments to the notice of subject teaching staff and discuss the implications. The subject staff might declare an innovation they wish to include in their forthcoming teaching programme. Arising out of this discussion, a schedule for individual staff training is drawn up. A three year cycle is normally expected for any new curricular development. In the first year, a member of the technical staff is prepared to take major responsibility for an innovation, closely shadowed by the subject lecturer. The responsibility passes to the subject lecturer in year 2. By year 3, technical support is expected to have lessened to that considered normally appropriate to the activity.

During the term, subject lecturers are expected to monitor the information technology provision within their subject. This includes opportunities in schools for students to use the technology. The monitoring will be used as a basis for further course development agreed between the subject lecturer and lecturer in information technology.

Because information technology capability is a national expection of all students, subject lecturers make use of student profiling to assess information technology capability on an individual basis. Student profiling is attractive because it encompasses work undertaken by each student in school. Subject lecturers also set specific assignments involving information technology. Again, these can be designed to include an element of school based practice. Teaching practice reports from lecturers or school supervisors are expected to include reference to information technology skills. The form and result of student assessment are discussed at the regular meeting between course lecturer and the Lecturer in information technology.

Despite the fact that our permeated training course ought to be reflecting what should now be happening in schools, students still experience problems in the school based component of the course. In theory there are significant advantages in locating some of the information technology education of students who plan to teach in schools. The process is curriculum focussed. Information technology is seen in context using relevant software in situ. Theory and practice are linked, promoting observation of pupils and real awareness of classroom issues. For the two institutions involved, school based training in information technology can assist the forging of better links between them and for either; it can be a catalyst for change. But the model assumes that each school has high information technology awareness and good resources. In practice this is still not the case. When we place students in schools they gain a considerable diversity of technological experience. Many schools are still having difficulty in meeting the information technology requirements of the National Curriculum and a significant number of students do not gain the experience with children we hope for—and which the Government's teacher education criteria require teacher educators to provide. For students, school based training in information technology can be an experience limited by the deficiencies of today rather than the good practice of tomorrow which the government's legislation demands and teacher educators work towards. For teacher educators, school based technological education is difficult to manage, hard to monitor, problematic to assess and expensive in time (Whiteman, 1990).

Despite the problems, recent statements by the UK Government indicate that in the future teacher education will be based more substantially in schools. In a recent policy statement, the Secretary of State for Education stated:

> I am quite sure that, in future, the whole process of teacher training needs to be based on a more equal partnership between school teachers and tutors in institutions, with the schools playing a much bigger part...I propose that in future four-fifths of the course should normally be school based... The schools and teachers involved in school-based training must be given real responsibility for the students' training programmes and their assessment (Clarke, 1992, Para 18 ff.).

If this policy is implemented, the implications for the technological education of new teachers could be considerable. We do not yet know which aspects of their training students will continue to receive in the 20% of course time remaining for institution based training. If that time consists of subject study then information technology could be squeezed out as teacher educators reduce their subject study to what they see as the bare essentials. Even in an institution like Cambridge, where subject staff integrate information technology within their teaching programmes, they will need to be ingenious in finding ways whereby information technology can be used to focus upon the essential curricular aspects and pedagogic issues that they need to cover. At Cambridge we have moved some way towards this because our permeation model has promoted the discovery of ways in which information technology can be fully integrated into the teaching of major curriculum topics and educational principles. In institutions where staff are less expert, technology could be threatened with neglect.

In this new school based training context, the expectation must be that students will experience information technology 'on the job' and be trained at least in part by their school mentors. This raises two imperatives. The first is that schools provide a suitably rich information technology culture for students. To this end there may be a need for teacher educators to conduct inservice training for school staff. Secondly, school mentors of students will need to develop skills in student supervision. Educating a student in the use of technology requires more skills than being able to use it oneself in the classroom. What will be required is a very close partnership between teacher mentors and teacher educators. Teacher educators will need to be flexible: conducting training for staff and students, working alongside both in the classroom, assisting in the monitoring and assessing of students' technological experience.

Until such time as the schools used for teacher education can develop technologically appropriate pupil learning and student training cultures, all this will place a considerable burden upon teacher educators. Where the staff of a teacher education institution is already committed to information technology, that burden can be shared. For other institutions, the burden on the technology specialists will be immense. One partial solution might be to locate the information technology education within the 20% time that students will still be expected to spend within the training institution. This makes effective use of expert staff and their good level of resources. It relieves the technological pressure on school staff and equipment. But such a course of action could have a detrimental effect. If information technology is taught back in the training institution it is divorced from classroom reality. It might also become divorced from curricular context since time constraints could prompt a focus on the delivery of technical competence rather than on curricular considerations. This is just as likely to apply where the information technology training can be delivered by subject rather than information technology experts. Moreover, institution based training does little for school development of information technology. Major agents for change in schools become the students themselves returning to classrooms with new found skills, rather than carefully planned inservice education. This places an unacceptable onus upon the student teachers. In any case, there will still be a need for teacher educators to work with schools to ensure continuity and progression in the information technology skills students develop.

The situation then is far from clear at the present time. The British Government has legislated for considerable development in the use of information technology in schools. It has legislated too for student teachers to be qualified to deliver that technology rich curriculum. But it remains to be seen if and how the partnership which must now exist to a degree not envisaged before between teacher educators and classroom teachers can provide the means whereby information technology can be put to really effective use in English schools.

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HYPERMEDIA

Hypermedia is a rare form of educational technology in that it has been adapted to a remarkable number of uses in such a short time. Furthermore, the terminology that defines that technology carries many varied connotations. Several major computer education textbooks, some written as recently as 1991, do not even include the term 'hypermedia.' In many cases, the terms *HyperCard* and *hypermedia* are used interchangeably. Some authors do attempt to define hypermedia:

> a linked, nonlinear knowledge structure with multiple data types—text, graphics, sound, animation, video
>
> Anonymous (by way of Michael Liebhold)
> *Learning with Interactive Multimedia*

> *...the ability to move around in and edit large amounts of information that's represented in many different forms - text, pictures, sounds, animation, and video disc frames*
>
> Carol Kaehler
> *HyperCard Power*

Even among these authors, the concept is so broad as to be almost all-inclusive. Perhaps that is as it should be.

The authors included in this section of the STATE Annual cover a broad range of both hypermedia and multimedia topics and innovations. The diversity represented can only serve to strengthen the notion that we as educators have only started to realize the potential of hypermedia.

Each article in this section represents a unique yet practical application of the uses of hypermedia. Higginbotham-Wheat and Kellogg utilize hypermedia and multimedia in their one computer classroom concept at the Center for Excellence for Science and Mathematics Education. Of particular interest is the incorporation of technology to enhance group learning. Braswell also addresses this issue of group learning through cooperative learning. The use of materials from Tom Snyder Productions, especially the multimedia program, *The Great Solar System Rescue*, is an innovative method of incorporating multimedia technology into a cooperative learning situation.

Reilly, Hull, and Greenleaf have used hypermedia to incorporate interactive learning into their teacher education program. Hypermedia allows for a flexible organization and presentation of information from a wide variety of sources. It can serve as a model for the incorporation of hypermedia into a remedial reading and writing program. Young discusses the incorporation of hypermedia into doctoral program courses at Spalding University. Of particular note is the necessity to include technology as an integral part of content courses. This integration of technology across the curriculum is one that cannot be emphasized strongly enough. Many of the students involved in the program realized that enhanced learning could occur through the use of *HyperCard*.

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Finally, Gillan and Williams report on a program model, *Where in Louisiana*, that utilizes hypermedia to provide a basis of instruction for state studies. Various regions of the state can adapt the hypermedia model to incorporate information relevant to the local area. This is an excellent example of the use of *LinkWay* in a realistic setting by real teachers.

The use of hypermedia in a cooperative learning situation is a reccurring theme throughout many of these articles. The concept of utilizing technology to enhance a specific style of learning is not new, yet many educators who might otherwise hesitate to use technology find that hypermedia enhances the incorporation of large amounts of information into the classroom. Although no one definition seems to be applicable when discussing the many types of hypermedia, one fact remains: hypermedia, in all of its facets, provides tools that are being utilized in classrooms across the nation. Our job is to further develop, investigate, and promote the use of these tools in order to better provide for our students.

The One Computer Classroom

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Abstract

This paper describes the *One Computer Classroom*, a method for using the computer, software, and peripherals to assist in teacher presentations and for students' use in collection and analysis of data. The term 'one computer' is more in reference to the method used than to the number of computers. It is also, however, an approach that deals with the economic reality of schools, namely that there will be a limited amount of hardware and software available for the exclusive use of science or mathematics classes.

We have implemented an inservice program to address the instructional needs of the schools in our state. While the concept is neither new nor unique to our state, the *One Computer Classroom* approach, as employed by the Center of Excellence for Science and Mathematics Education, incorporates technologies relatively untouched by educators into the unified framework of the state curriculum.

The advent of the personal computer incited a revolution in information processing unparalleled in history. Business and industry quickly applied the new technology in training and promotion, but education has remained several years behind, even while acknowledging technology's value. For example, the report *A Nation at Risk* (1983) recognized computers as the "fourth R" of education. However, the United States has spent millions of dollars on computer equipment only to find few students who can claim any substantial computer experience. Quantitative inequities exist, with anational average of 50 students for every computer. This proportion is dropping yearly as school systems buy more and more hardware, but, realistically, the inequities will continue through the 1990s and beyond if priorities within the educational system do not undergo significant change.

The STATE of Mathematics Achievement, the report of the 1990 NAEP assessment for the nation, gives us a real world perspective from which to evaluate computer implementation in the nation's schools. According to the report, 70% of the teachers surveyed never used computers in mathematics classrooms, yet only 28% reported that computers were unavailable. The problem, then, may not be the *quantity* of computers available; rather, it may instead be a lack of perceived benefits for such use. The Second National Survey of Instructional Uses of School Computers, which gathered information from more than 10,000 teachers and principals in a sample of over 2300 US schools, reported that much computer-related instruction in high schools is *about* the computer rather than drawing on it as a powerful instructional medium or productivity tool (Becker, 1986). Knupfer (1986) maintains that if computers are to support the curriculum rather than be the subject of the curriculum, there must be enough computers to support a maximum of two students per machine. Computer scientists and educators have envisioned for us a future classroom with a computer for every child (Papert, 1981). Many schools, however, will be unable to afford such expense.

Research tends to support the position that schools have not developed effective ways to use existing technology. The position that most researchers do support is that it is not the hardware that is important in the process of learning, but the fit to the instructional strategies used, the delivery medium (the hardware), the facilitator of instruction (the teacher), the content to be learned, and the learner.

Another problem in implementing new technologies in the schools may be that educational leaders—principals, superintendents and senior teachers—were certified long before this explosion in technology and may not be aware of its possible uses. In every recent survey that the Center of Excellence for Science and Mathematics Education (CESME) has conducted with either teachers or administrators, one consistent request is, "We need some computer training." When following up these requests we invariably find that the real need was not for computer training but, rather, how to use limited amounts of hardware effectively to enhance learning.

A new approach is needed to teaching with computers that capitalizes on theory and research in group learning. To address this need of the schools in our state, we have implemented an inservice program that we call the *One Computer Classroom* (OCC). While this concept is neither new nor unique to our state (Wainwright & Gennaro, 1986), our approach incorporates technologies relatively untouched by educators into the unified framework of the state curriculum. The *One Computer Classroom* is a method for using the computer, software, and peripherals to assist in teacher presentations and for students' use in collection and analysis of data. The term 'one computer' referes more to a method for using a limited number of computers than to the number of computers actually available for use. It is an approach that deals with the economic reality of schools, namely that there will be a limited amount of hardware and software available for the exclusive use of science or mathematics classes.

The purpose of the OCC program is to prepare teachers to use technology in their own presentations and in student investigations. When employing the OCC approach for presenting materials, the teacher has many options but the basic hardware tools are the computer, the projection panel, and the videodisc player with a large screen television set or monitor. Software tools are dependent upon the task to be performed.

Teacher use of the OCC equipment for presentation is the lowest level of use. At this level the computer produces dynamic overhead transparencies that may be supplemented by the videodisc player. Software may include linear presentation software such as *Persuasion* from Aldus, or hypermedia software such as *HyperCard* or *LinkWay*. Although considerable time must be spent in preparing presentations, the rewards are better organized presentations and student handout materials produced with the same software. Although a presentation of this nature can have great eye appeal and may hold student interest, it is still a lecture and has all the pedagogical limitations of that presentation mode.

This level of use can be quite effective for certain mathematics concepts such as the relationship between an equation and the graphic representation of that equation. In the physical sciences, the relationships among acceleration, velocity, and distance lend themselves to this approach . Good spreadsheet software with graphic capabilities is appropriate for these tasks.

The OCC approach can also be used quite effectively for full class investigations. For student investigation the primary tools are the computer, spreadsheet and database software, modems, and microcomputer-based laboratory (MBL) interfaces. Simulation software is also appropriate in these cases. A teacher might, for example, lead the class in an investigation of the nature of sound using the *Investigating Sounds* MBL from HRM Software. Using this product, various sounds are captured and compared in terms of frequency, wavelength, and amplitude. The teacher can interject *what if* questions, an experiment can be designed and conducted, and the students can interpret the data.

In mathematics, probability might be investigated by having each student roll a six-sided die a number of times and entering the results into a spreadsheet. The whole class may then use those data to obtain a frequency distribution for the entire class using a teacher-prepared template with appropriate formulae embedded in the spreadsheet. As in the case of the sound activity, the teacher can extend the investigation through the use of appropriate *what if* questions.

This approach is not without limitations. As in any class activity, the more aggressive students may monopolize discussions and less confident students may tend to defer to their peers in forming hypotheses and conclusions. To counteract the problem of limited hands-on experiences, the teacher can turn operation of the equipment over to the students after an initial orientation. As in any good inquiry lesson, the teacher becomes less conspicuous as student involvement increases.

The OCC approach, then, is not teacher-centered, and the practice of students pooling data is well established in good science classrooms. The computer and spreadsheet software are ideal for that purpose. Data analysis templates should initailly be prepared by the teacher. After some experience with the computer and spreadsheets, some students may begin to design their own templates. It is impressive to see how creative students become with the data analysis templates after they become familiar with the capabilities of a spreadsheet. Investigations that are particularly good for this approach involve those with a considerable probability of human and instrument error in the collection of data, such as distance and time measurements. The pooled data approach is also appropriate when used with videodisc-based experiments. One such videodisc, *Physics of Sports,* lends itself to direct measurement from the television screen and scaling to life size to obtain information about force and motion in sports.

Examples of the OCC approach can be seen in the CESME's 21st Century Partner Schools that serve as sites for real world research. 21st Century Partners are K-12 schools that agree to serve as research bases and to pilot instructional materials developed at the Center in exchange for technology training and classroom support. The CESME is currently working with one such school to improve their 9th grade physical science course using the OCC approach. The school was given funds with which to buy lab and demonstration equipment for the physical science classroom. Additionally, a computer and videodisc player were provided for the classroom as well as a computer, modem, and a printer for the teacher preparation area of the science department. The physical science teacher has been coached extensively in the use of the computer and videodisc in making her approach "hands-on" for physical science classes, integrating the technology into lesson plans. Classes were divided into small, cooperative work groups and the teacher was given instruction on some of the principles of classroom management using cooperative learning methods. CESME staff travels to the school regularly to troubleshoot equipment and assist the teacher in implementing this now activity-based course. While most of the CESME's efforts have been directed toward the physical science course, all of the teachers in the science department have been given accounts on the university mainframe computer and are able to dial up with the modem for additional long distance support and e-mail.

CESME work at a K-8 school in another town, on the other hand, is in mathematics. We have installed a modem, computer, videodisc player, and software, and in this school the teacher who is responsible for teaching computer classes is in close touch with CESME via modem and mainframe e-mail. CESME staff works with the teachers in this school to incorporate use of technology into an activity-based mathematics curriculum using manipulatives.

Before implementing any of the OCC activities in our 21st Century Partner Schools for the fall of 1991, the CESME conducted attitude surveys in the late spring among the students who would be directly involved in the coming year's project. Achievement test scores for that year were also compiled. Informal surveys in the form of teacher interviews were conducted to assess both teacher attitudes toward the subject matter and general content area competencies. While no formal surveys have yet been conducted for follow-up of our first year's implementation and no achievement tests been administered for the current year , informal assessment in the form of anecdotal evidence from implementing teachers and CESME classroom observations is encouraging.

The physical science teacher is enthusiastic about the OCC approach and recently presented a paper at the state science teacher's annual convention telling the story of her success and exhorting other teachers to implement our plan in their classrooms. She reported that this year's students have shown increased motivation for exploring topics that in past years seemed to be the least interesting and most difficult to understand. She told of added (and perhaps unexpected) benefits from the implementation of this technology into her formerly textbook-based classroom. One such benefit has been the interest shown in the technology itself by the female students, perhaps as a result of the teacher's modeling of interest and competence. Discipline, always a concern in a high school setting, is no longer an issue with this particular teacher. CESME staff have observed that there is increased evidence of cooperative learning in the classroom.

In summary; although achievement data are not yet collected, we predict that the following OCC benefits will positively affect student achievement:

- improved student attitude toward content area
- enhanced teacher self-confidence and competencies
- encouragement of hands-on activities
- promotion of cooperative learning
- increased accessibility to and interest in technology

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Cooperative Learning in The One Computer Classroom: Is Tom Snyder Right?

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Abstract

This paper is an overview of the concepts of cooperative learning incorporated into the educational materials developed by Tom Snyder Productions. Using the multimedia program *The Great Solar System Rescue* as an example, several of the key issues related to the use of technology in cooperative learning are addressed. Examples based upon the information presented in the program are given and evaluated in terms of practical application and educational validity.

Introduction

In this time of promoting the use of technology across the curriculum, we, as educators, must continually be aware of the impact that this promotion is making upon our captive audience of students. Are our students involved in learning? Do we place computers in the back of the room to be utilized as a reward for the student who has completed the assignment early? Do we keep our computers conveniently placed in a lab, allowing our students access only during the one week each semester the teacher is assigned lab use? Can we validate our student use of equipment either in the lab or in the classroom? Do the students benefit when we only have one computer for use in each classroom? These questions raise several issues that must be addressed as the use of technology becomes more pervasive and more commonplace throughout the curriculum.

Fortunately, one company, Tom Snyder Productions, has recognized the need for a practical response to many of these issues. This article will examine one multimedia videodisc program, *The Great Solar System Rescue*, to discuss how Tom Snyder Productions has developed materials that can be effectively utilized in a typical classroom setting to promote cooperative learning. In *The Great Solar System Rescue* groups of students search our solar system in an attempt to find lost space probes. Students utilize videodisc-based information as well as information contained in handbooks designed for the various fields of expertise (geologist, meteorologist, historian, astronomer) in which the students have been placed. Working together, students determine the best methods for finding and rescuing the probes. The concept of cooperative learning Tom Snyder Productions incorporates into much of their instructional material is exemplified in *The Great Solar System Rescue*. Additionally, *The Great Solar System Rescue* provides an excellent example of the use of videodisc technology incorporated into a learning situation.

Getting Started

"I was pretty nervous the first time I used the videodisc player, but it really was easy. Even so, I still always play a segment of the videodisc before the students arrive

just to make sure everything looks and sounds fine."

To many of us who teach the teachers, this sounds all too familiar. "Afraid," "nervous," and "worried" are words too often used by teachers when describing their reaction to utilizing multimedia technology. Even after instruction, many teachers on their own for the first time harbor an 'I hope this works' attitude. Fortunately, this is one area in which Tom Snyder Productions usually excels. In *The Great Solar System Rescue*, several pages of an excellent manual discuss setting up the equipment, getting started, and a general walkthrough of the program. Even more helpful for most teachers are the numerous worksheets, lesson plans, and follow-up activities that are included with the program. I have seen teachers with little or no experience in utilizing multimedia materials develop outstanding lessons based upon the information provided in the manuals that accompany the program. In addition, the manual discusses the concepts of cooperative learning and how to incorporate these into the class setting.

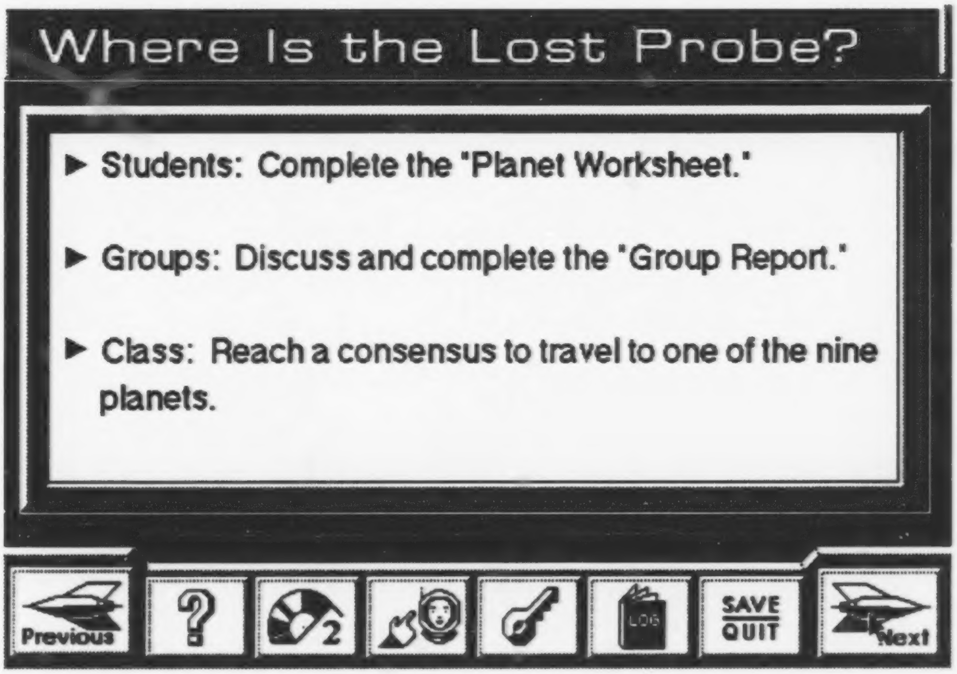
Cooperative Learning—Tom Snyder Style

What does Tom Snyder consider to be cooperative learning? A screen from *The Great Solar System Rescue* may serve as an example.

The use of terms such as 'discuss' and 'reach a consensus' serve to remind us that we are working towards a common goal—the main purpose is not to compete but to assist one another in developing an educated position upon which we can act. The manual describes cooperative learning experiences as those that involve 'ongoing interdependent relationships, shared goals, and shared decision-making.' While utilizing *The Great Solar System Rescue*, I have seen classes of both eighth graders and classes of adults completely involved in discussions about what decisions to make concerning the simulation. More importantly, I have heard both groups discussing reasons why their choices were valid, proposing arguments to support choices that the other groups had made, and eliminating through reasoning choices that should not be considered. This involvement with choices emphasizes the necessity for students to work both within groups and between groups, an important concept in cooperative learning.

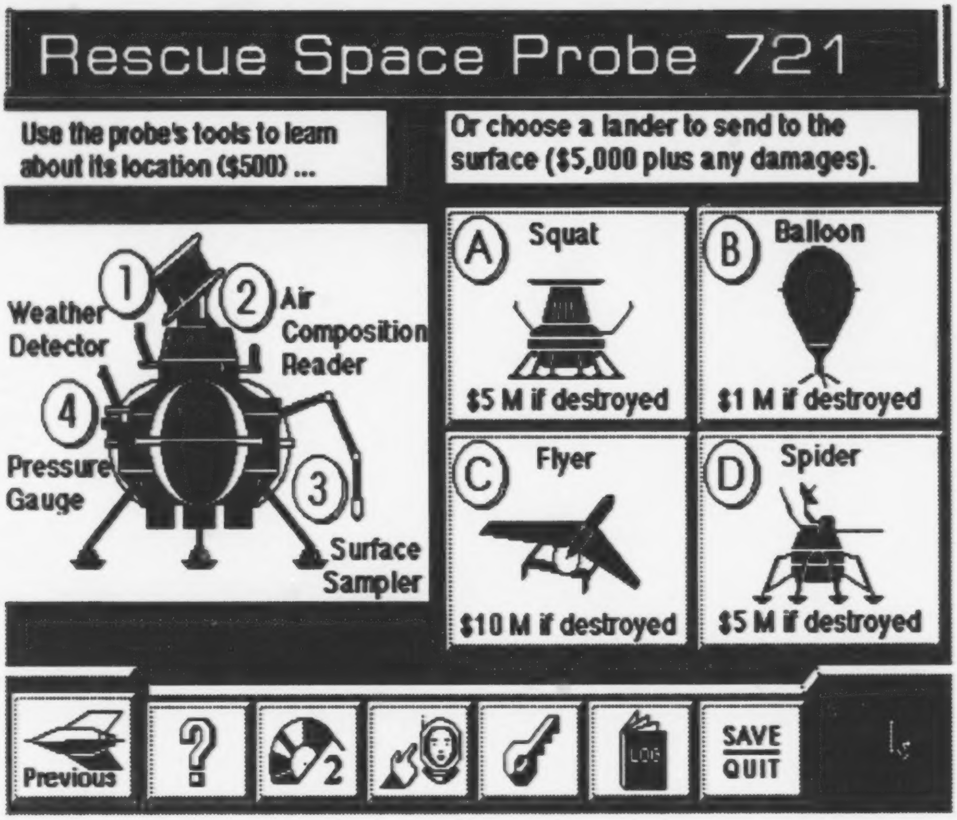
When students are confronted with making choices, several potential benefits can be found. We can examine some of these benefits through another example from the program.

Students have been divided into groups of astronomers, historians, meteorologists, or geologists. As the screen shows, different tools are available to the students. Each tool provides specific information to one of these



Where Is the Lost Probe?

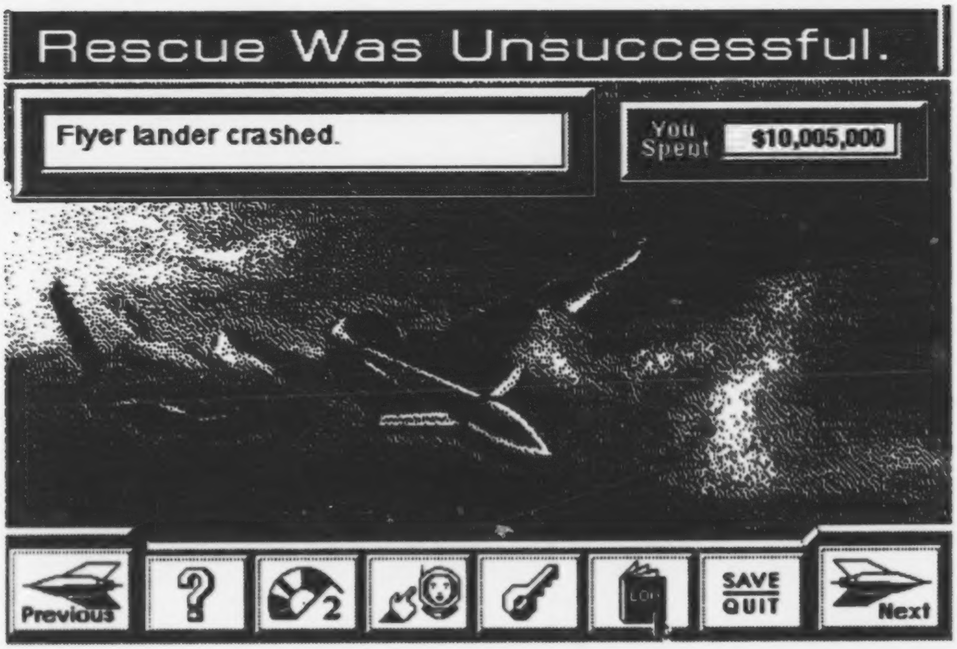
- ▶ Students: Complete the "Planet Worksheet."
- ▶ Groups: Discuss and complete the "Group Report."
- ▶ Class: Reach a consensus to travel to one of the nine planets.



Rescue Space Probe 721

Use the probe's tools to learn about its location ($500) ...

Or choose a lander to send to the surface ($5,000 plus any damages).



Rescue Was Unsuccessful.

Flyer lander crashed.

You Spent $10,005,000

groups. In order to spend the least amount of money, students must reach a consensus about which of the tools to use. If the landers are used and destroyed, additional costs are incurred. Astronomers must ask geologists about the surface of the planet; and geologists must ask meteorologists about the planet's atmosphere. Students must convince others that the plan of action they recommend is appropriate or they must show others why the direction they have chosen is not. No matter how the student is involved, the key issue is that the student is involved. The staff members at Tom Snyder (especially David Dockterman) have obviously worked in public schools—several recommendations, such as managing student teams and establishing rules for group work, allow those unfamiliar with cooperative learning to incorporate this type of group activity into their classroom setting.

How to get the computer to cooperate

The rescue was unsuccessful. The lesson was unsuccessful. The class was unsuccessful. Does Tom Snyder ensure success when utilizing his materials? The answer, fortunately, is no. Does Tom Snyder suggest ways in which students can learn from their mistakes. Yes.

> *After a couple of blown $5000 rescue efforts, students quickly appreciate the value of two or three $500 tests.*

Tom Snyder does, however, attempt to ensure success for the teacher who is using the materials. Topics such as 'Preparing Yourself', 'Preparing Your Class', 'Using a Macintosh Computer', and 'Some Basic Questions for Beginners' provide valuable information for both novice and experienced teachers. In addition, information on use with a remote or bar code reader has been thoughtfully provided for the teacher who does not have access to a Macintosh computer.

Whom is Tom Snyder cooperating with?

One of my favorite and most practical ways that Tom Snyder Productions keeps the classroom teacher in mind is located at the bottom of many of the pages of the teacher's guide: *Permission granted to copy for educational uses only.* When I see this on a worksheet or on an illustration that I know would make a great overhead transparency, I think "This company knows teachers.". Furthermore, I find that the thoughtful inclusion of information for those teachers who do not have access to computers is admirable, and made even more so in that such care has been taken to allow those teachers to make use of multimedia technology. This company has shown how cooperative learning can be enhanced through the incorporation of technology. Tom Snyder is cooperating with the fifth grade student who feels pride in working within a group. He is cooperating with the first year teacher who has been given a computer and does not know where to start. He is cooperating with the teacher who enjoys watching students learn.

Notes:

The quotations in this article were taken from the following sources:

Tom Snyder Productions. (1991). *The great solar system rescue teacher's guide.* Cambridge, MA.

Dockterman, D. (1990). *Great teaching in the one computer Ccassroom* (3rd ed.). Cambridge: Tom Snyder Productions.

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Using Hypermedia Cases in Teacher Education

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Abstract

The case method has gained popularity in teacher education as a way to encourage reflection on practical and theoretical issues that arise in the practice of classroom teaching. At the same time, portfolios of student work have begun to be used as an alternative means of assessment, primarily in writing classes. We have developed software that facilitates the construction of hypermedia portfolios and used this software to create interactive learning cases built around portfolios of student reading and writing. In this paper we discuss the case method of teacher education, portfolios, and one of the cases we have constructed as part of a research project on rethinking instruction in remedial reading and writing.

Overview

We have created a hypermedia composing tool called "Virtual Portfolio" designed to allow the flexible organization and presentation of data from qualitative research and other sources. In this paper we describe one use of that tool, the creation of literacy portfolios for teacher education. The portfolios include collections of students' writing, interviews with students and teachers in sound and text formats, images, and video clips of classroom interaction, student-teacher conferences, and individual reading and writing performances. Such collections can give teachers and student teachers access to qualitative research data in such a way as to encourage them to construct their own interpretations of these data and to reflect on the relationship between these interpretations and their own classroom experiences. Although these collections could be (and have been) made available independently of electronic media, we believe that hypermedia technology provides an environment particularly conducive to the presentation and exploration of qualitative data. Along with describing the tool we've built and illustrating this use of it, we will also review relevant literature on case methods in teacher education, the use of portfolios for assessment, and research on literacy.

Portfolios and cases

Our work has some things in common with both case methods for teacher education and portfolio assessment, both of which are popular trends in educational reform movements. Portfolios have received much attention as alternative forms of assessment of both students' and teachers' performance and have been widely used in writing classes at various instructional levels (cf. Freedman's review, 1991). Portfolios might include a variety of a student's written texts across time with teachers' comments and occasionally audiotaped readings by the student. As tools for assessing students' progress, standard portfolios are usually effective within the context of particular classrooms (e.g., Wolf, 1987, 1989). However, as tools for learning about reading, writing, and teaching, portfolios don't necessarily travel well beyond the particular contexts of their construction, as they are necessarily limited by the aspects of writing that are available to the reader in a given portfolio (cf. Phelps' discussion of "local knowledge," 1991). Thus, while the contextualized nature of portfolios is helpful at the local level for assessment, hypermedia offers a way to extend the community of a portfolio by capturing more of the context in which writing takes place.

An advantage that hypermedia has for capturing context is the availability of multiple modalities. Not only might an electronic portfolio contain print and audio, but video and images as well, and most of these materials in abundance. Such a system can also provide an interactive environment where students, teachers, and others can explore student writing in more depth. One part of our work, then, has been to create an electronic version of a portfolio, a system which can conveniently house extensive student data in many modalities and in easily accessible form.

Case methods of instruction have been widely used for many years in professional schools for law and business, and have more recently come to play a role in the education of teachers (Doyle, 1990; Shulman, 1986). A case is typically an instance of something—successful or unsuccessful classroom lesson, a solution to a classroom management problem—that has bearing on the practice of teaching. Cases are often presented as narratives built around a specific lesson, incident, or theme in teaching. For example, here is the beginning of one case that has been used in pre-service and in-service teacher education at Harvard University and the University of California, Riverside:

> *It was Sunday night. Laurie Cabot felt her stomach tighten as she switched off the TV and moved slowly down the hall toward her desk and the pile of student essays awaiting her comments. As she gazed out the window at the blinking Christmas lights, she recalled Tony's angry words before his stormy exit from her room at Gardiner High School on Friday afternoon.* (Merseth, 1990, p. 57)

This narrative about a high school English teacher becomes, as the case unfolds, a vehicle for examining the implementation of cooperative learning. Presumably, the narrative form of such cases offers a persuasive entry to theoretical issues on teaching and learning and leads teachers to reflect on their own practices. Another advantage of using case studies in teacher education is to supplement the observation of teaching practice. As Florio-Ruane (1990) points out, cases can be can repeatedly examined from multiple perspectives and can contain a variety of information that is not apparent to the untrained observer of a classroom. This is especially true, of course, when cases are carefully constructed and when they derive from long-term research projects.

One of the biggest differences between our work and cases is that we don't offer a well-constructed narrative as the starting point for discussion among teachers. Rather, we ask teachers to construct their own stories and interpretations from data that we provide. In a way, then, we are taking a portfolio and using it as a case. We hope that our "unconstructed" cases require an active, constructive role on the part of the student-teacher in order to reach some understanding about the issues raised in the case. Our cases are typically pathways through a large set of data drawn from a research project, and it is to that data set that we turn next.

Database from literacy research

For a number of years we have conducted field-based research on the literacy practices of students labelled "remedial," "developmental," "underprepared," or "vocational" in American schools and colleges (Hull & Rose, 1989, 1990; Hull, Rose, Fraser, & Castellano, 1991; Hull, Rose, Greenleaf, & Reilly, 1991). We have chosen to focus on such populations precisely because they haven't done well in school historically and because they have been singled out particularly as poor performers at reading and writing. Our ultimate goal has been to rethink remedial literacy education, and we hope to do this in part by offering a social-cognitive model of problematic reading and writing that will make poor literacy performances more understandable. However, before we can imagine more effective instructional approaches for those in remedial classes, we believe we need to question and transform the ways in which we typically think about students labelled "remedial" or "underprepared," and this includes examining our assumptions about students' abilities within a social-cognitive framework.

In the course of our research with remedial students in post-secondary schools, we have collected a range of data:

- We observed students in class, usually a writing or reading class, though at some sites we were also able, for comparative purposes, to collect limited observational data from literature, social science, and mathematics courses. In addition to taking field notes, we videotaped some class sessions which we then showed to teachers and students for comment.
- We tutored students, some students extensively, and tape-recorded all sessions. Most tutorials grew out of the writing classes, though some involved literature, social science, and computer science courses. All tutorials involved naturally occurring school assignments.
- From classroom observation and tutoring sessions, we

collected a number of representative school literacy materials: drafts of papers, textbook and workbook chapters, handouts explaining assignments, and quizzes, for example.

- Through both formal surveys and informal conversations (in cafeterias, in courtyards, at hamburger stands) and a schedule of questions worked into tutoring sessions at appropriate junctures, we collected considerable data on students' literacy and school histories, family and work histories, current reading and writing practices, the layout and demographic mix of their neighborhoods, and the organization of their daily lives.
- Using both speak-aloud and stimulated-recall techniques, we attempted to trace the cognitive processes involved in the reading, writing, test-taking, and problem-solving these students do.

Essentially, what we tried to do was to become part of the community of the classrooms we studied, to get to know students, and to collect a variety of data about students, their backgrounds, and their past and present literacy learning. They were generous in letting us into their lives and providing us with a wide range of data.

We have begun to analyze these data, constructing case studies to illustrate phenomena that have recurred in our larger data set and that also illustrate cognitive and social processes that we think bear in an important way on literacy instruction (Hull & Rose, 1989, 1990; Hull, Rose, Fraser, & Castellano, 1990). The traditional way of influencing practice would of course be to make such research reports available to teachers, and this we have done, particularly through the technical report series of the National Center for the Study of Writing and Literacy. Another approach, however, and one that seems intuitively more productive, is to make it possible for teachers themselves to engage in the same kind of socio-cognitive inquiry that leads one to trace the connections between the mind of the student, the classroom, and the community beyond.

To this end, we have developed materials around which such inquiry could be centered. Briefly, we have taken chunks of the data from a research article and reformatted these as an intellectual puzzle to be presented to teachers or teacher-trainees for discussion and reflection. We first ask teachers to explain the problematic performance of the student on the reading or writing task, and then to suggest some teaching practices on the basis of this explanation. By having teachers account for students' unexpected literacy performances, we hope to encourage them to assume that the student's performance has a history and a logic, thus simulating a turn of mind that we argue is a productive one. To begin with we relied primarily on paper versions of these case studies, but because these versions set certain limitations on the kind of inquiry that is possible, we have more recently developed a multi-media data base that we believe avoids some of the limitations of print.

A sample "Portfolio Case Study"

To illustrate our approach, we will next contrast three different ways that data from our project might be presented, three different artifacts: a traditional research article published in a journal, a case in paper form, and a case constructed in the multi-media composing environment "Virtual Portfolio."

We will focus on the case of Tanya, a community college student involved in a basic reading and writing program. Nineteen years old at the time of our research, Tanya grew up in the inner city and bounced from high school to high school, five different ones during her senior year. We tutored Tanya for about four months, helping her with assignments from her community college classes and with outside literacy tasks such as the reading material that she used to prepare for the GED. Tanya wanted to be a nurse; she dreamed of a middle-class life style. Although her writing and reading improved dramatically over the period that we knew her, Tanya's literacy performances would still strike most people as very problematic, the essence perhaps of what is popularly called a literacy crisis.

From the abundant data we collected about Tanya, we constructed a case study centering on a particular literacy task that we asked her to carry out: writing a summary about an article on nursing. We published one article reporting this case study (Hull & Rose, 1989), and in it we presented some of our data and offered our interpretation of the case. We argued, for example, that despite the flawed quality of the summary Tanya produced—its errors, its lack of conventional organization, its apparent plagiarism—her writing had a logic if you knew Tanya's history and the rules and strategies she used for composing. We also argued that there was something fundamentally literate about her performance—her appropriation of another's language to establish group membership.

In addition to writing this article, we took much of the data presented in that article—the summary that Tanya wrote, the source text that she was summarizing, snippets from our interviews with her, background information that we collected about her former schooling—and reformatted them in paper form structured with organizing questions—for example, " How would you characterize the 'literacy problem' that this piece of writing represents?"

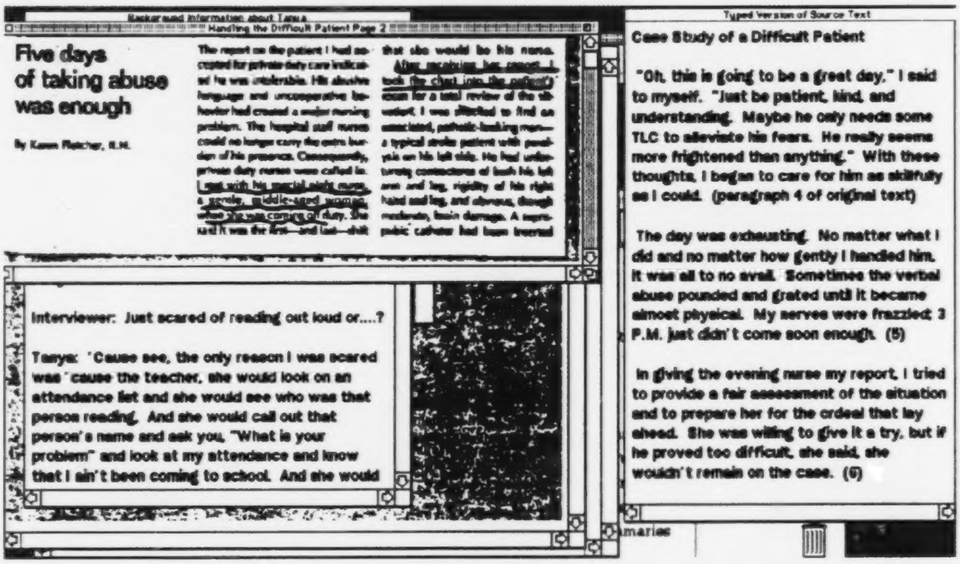
Our third approach, and the one we are focussing on in this paper, was to collect data about Tanya. We used the types of data mentioned above and added others, then organized them in our multi-media composing environment. This environment presented the data in print form, but also took advantage of other modalities as well: sound, images, and video. So, in the article format and the paper format, we were able to talk about Tanya's composing, but in the multi-media composing environment, we could make available a video of her text as it emerged on the page. In the article and the paper case we could provide transcripts of our interviews with Tanya; in the multi-media composing environment, we could provide audio excerpts in addition to the transcripts. In the article and the paper case, we had space to reprint only the summary that Tanya wrote; but in the multi-media composing environment, we could provide many additional writing samples that Tanya did—a poem about her boyfriend, an expository essay in multiple drafts, and narratives about school.

While each of the formats that we have described offers some insight into the issues involving reading and writing instruction uncovered during the research, each does so with different strengths and weaknesses. In particular, the journal article builds a narrative telling about a particular literacy event-- writing a summary of an article -- to raise some questions about our conceptions of remedial reading and writing. In so doing, the article necessarily focuses on a particular path through selected pieces of data in order to support the conclusions offered by the authors. Given the space limitations inherent in print, such an article encourages particular kinds of interactions on the part of the reader-- comparing the experience of Tanya against their own or that of their students, or considering what kinds of remedies they might consider. These interactions, while not imposed by the writers, are colored by the narrative form, which the reader experiences linearly, with predrawn conclusions.

The paper case, in contrast to the written article, was designed as an interactive exercise to encourage discussion and thought about some of the same issues raised in the article. The paper case itself makes use of the same data excerpts that are found in the written article, although they are presented as starting points for inquiry rather than as examples of inquiry that has already been conducted. In this way the case encourages reading as inquiry with the goal of relating that inquiry to practice.

The computer-based case expands on the written version with more complete selections of data, as well as making a much larger selection of data available to the reader. These data are presented in print, audio, image, and video formats, and any element can be accessed at any time by the reader, although a particular path of key points has been built as a guide. Figure 1 illustrates the presentation of multiple data simultaneously to encourage a reading of the case that focuses on the wide range of factors that might have impact on a student's reading and writing. In this example, the student's original text (retyped) is open on the right side, with a picture of the source article, an interview with the student about her writing, and additional background information about the student available on the left side of the screen. Audio for the interview can be accessed via a button that is not visible.

Figure 2 shows more interviews with the student about her writing (with audio), and transcripts of a tutorial session with her and a discussion concerning interpreta-


Background Information about Tanya
Handling the Difficult Patient Page 2
Five days
of taking abuse
was enough
Typed Version of Source Text
maries

Interviewer: Just scared of reading out loud or....?

Tanya: 'Cause see, the only reason I was scared was 'cause the teacher, she would look on an attendance list and she would see who was that person reading. And she would call out that person's name and ask you, "What is your problem" and look at my attendance and know that I ain't been coming to school. And she would

Case Study of a Difficult Patient

"Oh, this is going to be a great day," I said to myself. "Just be patient, kind, and understanding. Maybe he only needs some TLC to alleviate his fears. He really seems more frightened than anything." With these thoughts, I began to care for him as skillfully as I could. (paragraph 4 of original text)

The day was exhausting. No matter what I did and no matter how gently I handled him, it was all to no avail. Sometimes the verbal abuse pounded and grated until it became almost physical. My nerves were frazzled; 3 P.M. just didn't come soon enough. (5)

In giving the evening nurse my report, I tried to provide a fair assessment of the situation and to prepare her for the ordeal that lay ahead. She was willing to give it a try, but if he proved too difficult, she said, she wouldn't remain on the case. (6)

Figure 1. Tanya's summary of an article

tions of Tanya's difficulties with literacy tasks. This latter text illustrates how the case can grow, as a variety of readings can be added and then become available for future readers.

The addition of video to the case (Figure 3), whether integrated digitally into the hypermedia document or available on a videotape, provides a richer sense of the immediate context.

Discussion

Over the last two years we have tested these materials, both the print-based and computer-based versions, with approximately ten groups of teachers and tutors during inservice sessions, regional and national conferences, and teacher research meetings. We have tape-recorded or audio-taped these sessions, analyzed the transcripts, and begun to write a paper reporting the results in which we situate our work in current debates about multicultural education (Greenleaf, Hull, Reilly, in preparation.) Briefly, we have found that teachers did engage in inquiry with the materials, trying to account for the flawed student performance in the cases. They also became reflective as they looked in detail at the history of the students' literacy performances, thinking critically about the contexts of instruction and pedagogical practice. Teachers brought ideas about cultural difference and diversity to their reasoning about the cases, and they constructed multiple ways of treating the problems they had identified in the cases, thinking through possible pedagogies in the company of other teachers. Finally, we found that discussions of the materials didn't necessarily inhibit deficit orientations, but rather provided windows onto teachers' beliefs that could then become the basis for further discussion.

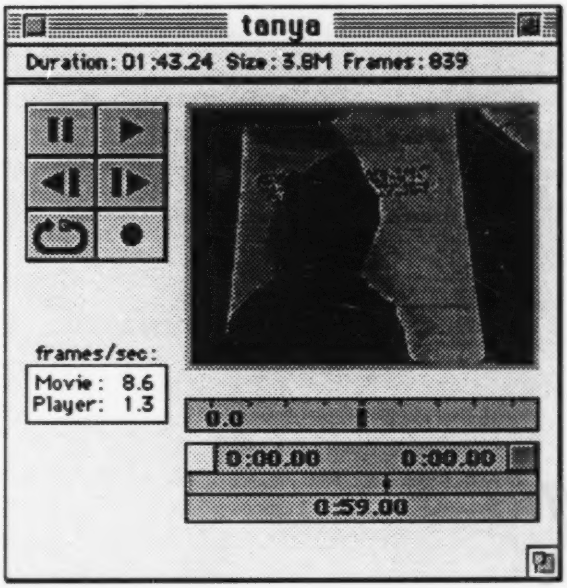
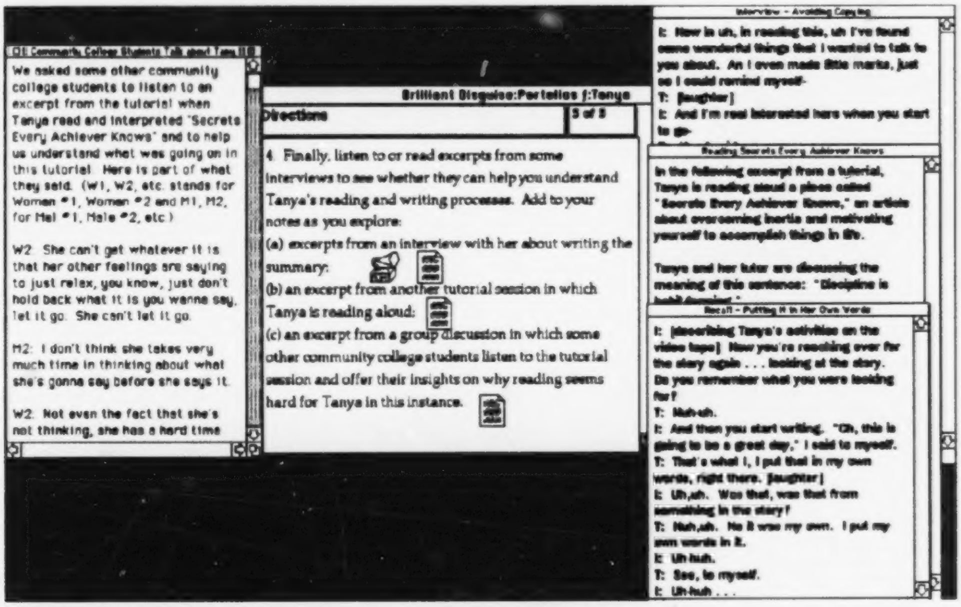


Figure 3. Digital Video Clip of Writing Episode


Community College Students Talk about Tanya
Brilliant Disguise:Portfolios ƒ:Tanya
Directions
3 of 3
Interview - Avoiding Copying
Reading Secrets Every Achiever Knows
Recall - Putting It In Her Own Words

We asked some other community college students to listen to an excerpt from the tutorial when Tanya read and interpreted "Secrets Every Achiever Knows" and to help us understand what was going on in this tutorial. Here is part of what they said. (W1, W2, etc. stands for Women #1, Women #2 and M1, M2, for Mal #1, Male #2, etc.)

W2: She can't get whatever it is that her other feelings are saying to just relax, you know, just don't hold back what it is you wanna say, let it go. She can't let it go.

M2: I don't think she takes very much time in thinking about what she's gonna say before she says it.

W2: Not even the fact that she's not thinking, she has a hard time

4. Finally, listen to or read excerpts from some interviews to see whether they can help you understand Tanya's reading and writing processes. Add to your notes as you explore:

(a) excerpts from an interview with her about writing the summary:

(b) an excerpt from another tutorial session in which Tanya is reading aloud:

(c) an excerpt from a group discussion in which some other community college students listen to the tutorial session and offer their insights on why reading seems hard for Tanya in this instance.

I: Now in uh, in reading this, uh I've found some wonderful things that I wanted to talk to you about. An I even made little marks, just so I could remind myself-
T: [laughter]
I: And I'm real interested here when you start to go-

In the following excerpt from a tutorial, Tanya is reading aloud a piece called "Secrets Every Achiever Knows," an article about overcoming inertia and motivating yourself to accomplish things in life.

Tanya and her tutor are discussing the meaning of this sentence: "Discipline is

I: [describing Tanya's activities on the video tape] Now you're reaching over for the story again . . . looking at the story. Do you remember what you were looking for?
T: Muh-uh.
I: And then you start writing. "Oh, this is going to be a great day," I said to myself.
T: That's what I, I put that in my own words, right there. [laughter]
I: Uh,uh. Was that, was that from something in the story?
T: Nuh,uh. No it was my own. I put my own words in it.
I: Uh-huh.
T: See, to myself.
I: Uh-huh . . .

Figure 2: Background information regarding Tanya's interpretation of text

As we continue our work with the cases we have developed, we hope to come to some clearer understanding of the differences between the print and computer-based materials, and to use that understanding to improve the design and functionality of our multimedia composing tool. In addition, we have begun to work with individual teachers to assist them in constructing interactive portfolios/cases of their own students, something we see equally as valuable as having teachers interact with the cases we have put together. Another possibility we have not yet explored is to work with students to construct their own interactive portfolios using our software.

In addition to promoting reflection and discussion on teaching and learning, such interactive portfolios offer teachers and teacher trainees opportunities to consider issues that might not normally be present in the environments they are accustomed to. While browsing a rich portfolio that presents data about students from diverse backgrounds is not a substitute for interacting with such students in the classroom, it can, we suggest, offer a learning experience that students might otherwise go without. In addition, experiencing research data in this way, rather than in the standard format of a published article, can give teachers a different feel for what educational research can be, and how it can provide insights that can affect and be affected by practice.

Acknowledgements

The development of "Virtual Portfolio" was funded in part by the Apple Classrooms of Tomorrow (ACOT) project of Apple Computer, Inc.

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Computing Across the Curriculum with *LinkWay*

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Where In Louisiana is a program model using IBM *LinkWay*, an authoring program that allows the integration of educational disciplines in a computer environment. This model addresses four areas of action learning by:

1. initiating computer literacy through the use of keyboard skills, introduction of programming in an authoring application, and the exposure of the student to the DOS environment and the application of computer graphics;
2. giving relevance to state and local studies through the search for facts, history, demographics, maps, industry, and natural resources as outlined in state curriculum guides;
3. incorporating link knowledge through design and research activities;
4. emphasizing cooperative learning through student/ teacher and group activities.

Where in Louisiana provides an example of *LinkWay*'s capability and a manual for teachers and students to acquire skills to become competent users of *LinkWay*. Computer literacy is enhanced through the application of keyboarding, mouse manipulation, and the use of basic DOS commands. Keyboard skills are used in *LinkWay*'s simple text editor,which emulates a word processor. The program uses the mouse with a simple menu format similar to most computer programs. The paint program offers familiar tools to create graphics for a presentation.

LinkWay uses an object-oriented authoring environment to introduce students to high level programming. A DOS shell can be used to import files created or captured in an external program such as a paint or word processing program.

Users can progress to higher level programming through *LinkWay*'s scripting language for sophisticated multimedia presentations. Buttons that link peripheral hardware to incorporate audio and video (CD ROM, laserdisc, and VCR) are options that *LinkWay* provides using a scripting language. It is supported by complimentary programs (*Storyboard Live*, *MPC*, and several shareware programs). Graphics can be converted to the *LinkWay* format through a screen-capture program. *LinkWay* mode options allow for five resolutions, (CGA or VGA) based on the hardware configuration. The program must operate in an IBM compatible hardware environment with a mouse. A color monitor and a hard drive are recommended.

Where in Louisiana was created as an interactive presentation to enhance and expand state studies (Louisiana Social Studies) offered in the eighth grade and mandated by bulletin 741. The potential for the development of a comprehensive Louisiana studies program with the scope and sequence covering the course is evident.

Each parish or region of the state can tailor relevant information to extend the curriculum to local studies. Gathering and compiling local facts and information provides student motivation and individualizes studies. Required research skills are honed by working with relevant history, demographics, government, maps, pictures, and general facts unique to a parish, community or region of the state. Information can be compiled to offer a current and comprehensive vehicle for maintaining an updated state studies curriculum.

The logical sequence of producing a *LinkWay* presentation requires planning and research before organizing information in the program environment. *Where in Louisiana* provides sufficient examples and models for a classroom teacher to imitate a research activity that correlates with the scope of *Where in Louisiana*. Individual and group/team research becomes an obvious method for compiling needed information. *Where in Louisiana* is multi-level and open-ended, offering a means for teams of students to develop information unique to each student's interest. Project organization may be as follows:

1. teacher or instructor.

2. *LinkWay* program coordinator
    a. teacher
    b. computer science instructor
    c. proficient student

3. team project coordinator
    a. student with leadership abilities to:
        1) coordinate overall project
        2) assist group integration of graphics, research

4. group leaders for:
    a. graphics
    b. research
    c. composition
    d. programming

5. team members.

Students can include any system of organization that meets the needs of the activity. As each page is created, flow charts, time lines, and story boards help to keep the project on track.

Where in Louisiana provides a parish model (Sabine Parish) as an example of directions to be followed in developing other parish or region models. A graphic outline is provided for each of the 64 Louisiana parishes. *LinkWay Paint*, the graphic module of *LinkWay*, is used to expand a parish outline to include terrain details, location of transportation systems, and towns and communities.

Resource materials are available through libraries, Chamber of Commerce offices, tourist bureaus, Courthouse and city government agencies, and state governments, and interviews with individuals. *Where in Louisiana* is open-ended and any creative approach may be incorporated in the development of a parish or community model.

HyperCard: A Tool for Learning and for Instructional Design

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Abstract

Students in a doctoral level Learning Theory and Instructional Design Course at Spalding University in Louisville, Kentucky, used *HyperCard* as a tool for learning. Using *HyperCard* to manage and present their annotated bibliographies, the students gained access to information more efficiently and more effectively. Using *HyperCard* to create storyboards for their instructional designs, the students were able to spend more time on the content of the design and less on its execution. Because *HyperCard* was new to them, students learned how to learn as they mastered the *HyperCard* process. They realized that they could not read their way to understanding and that they could only learn by doing. This paper will share the process and content used in the course and discuss the products of the students' learning.

Introduction

Teachers cannot use technology unless they understand how, when, and where to use it. It is not enough for Spalding University to offer special courses in an education technology program as it has since 1983. We at Spalding are challenged to upgrade our curricula and programs, with our commitment to a university mission "meeting the needs of the times." Our commitment includes the following goals:

- Spalding University is a place where knowledge is created, not merely transferred.
- Our students are knowledge navigators and knowledge generators, not mere information gatherers.
- Our students have opportunities to *use* technology to learn, not merely learn *how to operate* machines.
- Our students use technology as an integral part of content courses across undergraduate and graduate curricula, because instruction that separates content, process, and assessment is ineffective.

In 1990, Spalding University began a Doctor of Education in Educational Leadership Program. Because our prospective students already hold full time positions in education, government, industry, business, and health science, we selected a cohort group format to deliver core courses. The core component of the program consists of thirty six semester hours. The fifteen students in each cohort group take six credit hours each semester. In the rest of the sixty credit hour program, students complete a twelve credit hour cognate component, a three credit hour externship, and a dissertation.

The Learning Theory and Instructional Design Course met all day Saturday in a seminar format, five times during the fall semester. The five class sessions were separated by either three or four week intervals. Each of the first four class meetings included a two and one half hour *HyperCard* workshop.

Each students in the first cohort group entered the program with at least a master's degree in education or in a related area. Many had been away from formal course work for ten years or longer. Their ages spanned three decades, their work experiences were diverse, and they had little experience with technology beyond word processing. Their motivation, scholastic aptitude, and perseverance were high. This presentation describes their experiences with *HyperCard*, as they learned it and applied it in course assignments.

Hands-on *HyperCard* Workshops

Guided by a commitment to "meet the needs of the times," we extended the content of the Learning Theory and Instructional Design Course in the second year of the Educational Leadership Doctoral Program to include an introduction to technological applications in the form of *HyperCard*. That course includes appropriate learning and instructional design theory and four hands-on workshops[1] to enable students to use "*HyperCard*: A Learning Tool."

For the first three workshops, the professor (Young, 1991) created stacks for concept demonstration. For the last workshop, the class used *HyperScan* with the Apple Scanner and *HyperSound* with Farallon's *MacRecorder* for digitized sound and *MacinTalk* and *HyperMacintalk* for synthesized sound.

These stacks were used one at a time in a discussion and demonstration format with a computer and a projection device for the group of fifteen doctoral students. Numerous "what if" questions and "for example" responses ensued. The students' reactions were more positive than negative. Most were surprised to find the Macintosh and *HyperCard* so easy to use. They realized that the information that they needed could be read somewhere on the screen.

At the first three sessions, students were given print copies of the stack in use. The stacks were available on the hard disk drives of the computers in the Lab throughout the semester. The students could access the stacks at any time; likewise, the scripts were available for study and use. The scanner and *MacRecorder* were in the lab for student use.

The students were expected to improve their knowledge of *HyperCard* in hands-on, out-of-class lab time. The *HyperCard Help and Reference stacks* and workshop stacks 1, 2, and 3 were available on the hard disk drives in the lab. No other resource material was used in instruction or practice. Because these *HyperCard* workshops were embedded in a Learning Theory and Instructional Design course, students were able to apply the fundamental principles of design to *HyperCard* stack development. Students were not expected to master *HyperCard*, but they were encouraged to use it for two specific tasks.[2]

Student Applications Using *HyperCard*

The students approached this use of technology with trepidation. Often their expenditure of time learning to use *HyperCard* exceeded the time they had budgeted for the task. The professor and the two computer- experienced members of the cohort group worked with them. At the first session of the course, the students knew that they would be encouraged to use *HyperCard* for developing an annotated bibliography on an approved learning theory topic of their choice and for developing the storyboards for the design phase of their instructional module.

Annotated Bibliographies

For their first assignment, students prepared an annotated bibliography on some aspect of learning theory. Students conducted a literature search, selected appropriate print and nonprint resources, and wrote their annotated bibliographies. Those annotated bibliographies created a picture of the state of knowledge on selected learning theory topics.

As part of the third class session, students viewed and critiqued sample annotated bibliography stacks that had been prepared as class assignments by graduate students in Spalding's Technology in Education Program. A simple format for a stack was created by the class and students were invited to use that format or to create their own formats for use in developing their annotated bibliography stacks.

The students were encouraged, but not required, to use *HyperCard* to present their annotated bibliographies at the fourth class meeting. Ten students chose to do so. The consensus among these students was that *HyperCard* allowed them to access their information more effectively and more efficiently than conventional presentations. We used this as an opportunity to work with *Find* and *Sort*. The print features of *HyperCard* enabled students to have paper copies of their bibliographies.

Five students used the traditional word processed format. Those students cited lack of time, fear of failure, and availability of word processing on their own home or office computers as the advantages of that format. They also expressed difficulty in scheduling time to work in the computer lab at Spalding.

Instructional Design Storyboards

The final assignment required students to use appropriate learning theory to plan an instructional design. As part of the fourth class session, students prepared a needs assessment for their instructional design. This needs assessment included determination of these elements:

- learner characteristics of their target audience
- environment of planned use
- constraints of the development process
- learner outcomes: goals
- objectives for attaining goals
- assessment items congruent with each objective
- prerequisite skills and knowledge the learner must possess.

The plans were presented and critiqued by the panel of fifteen doctoral students. This step is one of the two most critical review points. The other is the review of the design or prototype. The students were to complete the design or prototype for the last class session.

Students had to develop activities to meet each objective, determine methods and activities for reteaching or remediation for each objective, and decide how to report learner performance. They were to use Gagne's events of instruction (1988) where appropriate in the creation of their storyboards. The students' task then was to develop a skeleton of their stacks so that reviewers could see their intended lessons.

The students were encouraged, but not required, to use HyperCard to present their storyboards at the fifth class meeting. Twelve students used HyperCard to present their storyboards. The designs were presented and critiqued by the panel of fifteen doctoral students with the following checklist (Hannafin &Peck, 1988) for evaluation:

- lesson involves learner by requiring meaningful interaction
- lesson adapts to needs of individual learners
- lesson provides for adequate remediation and reteaching
- lesson provides for adequate amount of learner control
- lesson will maintain learner interest
- learner knows lesson objectives
- learner is aware of prerequisite skills and knowledge
- learner is aware of correctness of responses
- instructions are clear
- positive feedback is appropriate
- negative feedback takes advantage of the teachable moment
- assessment items are congruent with objectives.

This is the second most critical review. Designers repeat this cycle of create/review/revise many times on their way to the finished product.

One of the three students who did not use *HyperCard* to present storyboards used word processed overhead projector transparencies. The difficulty he encountered in attempting to demonstrate the necessarily nonlinear plan served as a dramatic reinforcement of the usefulness of *HyperCard* for the storyboard design process. Both he and the other cohort members noted the obvious difference in the efficiency of his presentation when compared with the *HyperCard* demonstrations.

A second student who had used *HyperCard* for his annotated bibliography assignment decided to use *Pagemaker* for his instructional design storyboards. It was available in his office and he had learned to use it. He tried to eliminate the difficulty of demonstrating the nonlinear plan by repeating storyboards where they were needed. For example, when he wanted to go to frame number four, he put a copy of frame number four in place. As a result, frame number four was repeated many times and the stack was unwieldy. Again, both he and the other cohort members noted the obvious difference in the efficiency of his presentation when compared with the *HyperCard* demonstrations.

The third student remained adamant in her belief that only low level instruction could be delivered with a computer; she made a paper format presentation. She used the format she has always used for instruction. She did not accept the use of technology for instructional material. The students did not expect her to do otherwise and made no judgment on her choice.

Conclusion

With the *HyperCard* medium, one that none of the students knew prior to the course, students experienced "learning how to learn" as well as "mastering content." They realized that they could not read their way to understanding. The best way to learn to use *HyperCard* was repeated hands-on applications including completion of annotated bibliographies and other projects.

Students learned to use HyperCard to manage information in a new, dynamic work environment. They recognized that through their exposure to *HyperCard,* they could build multi-sensory education applications: combinations of sight, sound, and touch that can enhance the probability that learning will occur.

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[1] ***HyperCard* Workshops**

HyperCard Workshop I

- Basic operation of a Macintosh computer
- Stack 1: Introduction to *HyperCard*
  - *HyperCard* anatomy (cards, backgrounds, stacks)
  - creation of a stack, title card (layers)
  - *HyperCard* objects (information screens)
  - the tool palette (painting and drawing graphics)
  - Buttons and fields: Overview (objects menu)
  - simple button scripts (navigation)

HyperCard Workshop II

- Stack 2: Introduction to Scripting
  - navigation palette (go menu)
  - edit menu (undo, cut, copy, and paste pictures)
  - messages and handlers
  - visual effects, show/hide, choose/drag, push/pop
  - playing sounds (harpsichord...)
  - naming objects
  - working with information in "containers": fields

HyperCard Workshop III

- Stack 3: intermediate scripting
  - getting Information from the user: ask, answer
  - control of interaction: (decision, repeat, find,sort)
  - overview of properties

HyperCard Workshop IV

  - advanced sound and graphics
  - databases with scanned pictures: scanner
  - digitized sound: *MacRecorder*

[2] In the Spring 1991 Communication and Information Course, doctoral students will work with *HyperCard* and multimedia: videodisc, digitized video, and CD-Rom applications.

INSERVICE & GRADUATE EDUCATION

Section Editor:
Doris M. Carey

The Special Needs of Practicing Teachers

Classroom teachers clearly have special needs in learning how to implement and integrate technology. The most obvious are access to equipment and the time to learn how to use the technology. Related to these are the need for effective models of computer use, assistance and feedback from experts, and an opportunity to reflect on and share ideas about issues that emerge.

The six authors in this section address this broad spectrum of inservice needs. For Brush, Knapczyk, & Hubbard, the greatest need of teachers of children with learning and behavior problems in rural Indiana schools is field-based delivery of instruction. They designed an elaborate system of distance education to reach these teachers. In their paper, they describe the benefits and shortcomings of an initial system, then report the progress of a revised and updated system. The reader will certainly conclude that the content of the article easily applies to teachers in all areas and at all levels.

Ling describes a partnership between a high school and college in Oregon designed to meet the simultaneous education and training needs of preservice and inservice teachers. This unique partnership provided a valuable context for preservice teachers while offering direct assistance to the classroom teacher. Additional benefits included an efficient use of resources and assistance from college faculty for teachers in the schools.

Cashman and McCraw describe their concept, School Day Inservice, as a means of solving the problem of learning time for teachers. Although many obstacles in equipment access and scheduling had to be overcome, they implemented a model for technology use that occurred during the regular school day while a coordinator worked with children in the same facility where teachers did their learning. Part of the learning process included an opportunity for teachers to observe an expert interacting with children and the option of participating in this interaction when they were ready. Although many schools require that teachers accompany their students to the computer lab, this model offered a structure for all teachers involved to meet specific learning objectives.

In their articles, McKenzie and Beckman and Keirans design special courses for teachers to meet specific learning objectives that transfer to the classroom. McKenzie's course focuses on media education so that teachers can use a wide variety of media with high-risk students. Beckman and Keirans design their course so that teachers will return to the classroom to teach process writing using word processing. In both cases, course requirements are designed so that students report on their implementation practices and have an opportunity to discuss problems and receive feedback. Such models point out the necessity of bridging the gap between the university classroom and the practitioner's classroom—

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isolated training events are no longer effective, nor are training programs that focus on technology rather than on children's learning.

Carey & Goulding offer a simple model for previewing and selecting software that is designed to remove the tedium from the process, help teachers select software that matches their teaching styles and student needs, and share their impressions of the adequacy of software. They base their suggestions on the idea that, although teachers learn an elaborate system of evaluation in their coursework, they rarely apply this process when selecting software for their students.

Focus on Teachers

In the late 1970s, inservice educators focused largely on the need to teach programming so that all teachers could become software designers. Then in the 1980s, inservice events focused largely on teaching teachers to use the technology. In the 1990s, teacher inservice models are gradually shifting to a curricular emphasis as the difficulty of integrating complex media with shifting curriculum are recognized.

The articles in this section deal largely with these evolving teacher needs, and they also provide school-based, time-saving models that provide a realistic context for applying new knowledge and skills. Teachers, students, and technology are seen as an inseparable entity in the educational process. The authors featured here are successful in addressing the difficulties that arise in providing meaningful models and in suggesting solutions for overcoming these difficulties.

Using Technology to Facilitate Field-Based Training of Practicing Teachers

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Dennis Knapczyk
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Abstract

This paper focuses on the technology used to deliver, monitor, and evaluate an innovative staff development program formed as a cooperative arrangement between Indiana University and several rural school corporations and agencies. This program uses distance education facilitated by interactive microcomputer and communications technologies to provide a wide range of on-the-job training activities to teachers in rural communities.

Research conducted by Helge (1991, 1984) and others has shown that the professional staff of many schools and agencies are ill-prepared for the responsibilities they are given when providing services to at-risk children and youth. Teachers often claim that their training has not properly prepared them for children with diverse learning and behavior problems and that they cannot effectively use resources and expertise within their schools to improve their teaching and help meet the unique needs of these students.

Upgrading the skills of personnel and improving the quality of educational services requires new approaches to planning and staff development opportunities for those working in rural communities. The success of such efforts depends upon the ability of universities, school corporations, and state and local agencies to form partnerships in order to design and deliver effective professional development activities. This paper will describe an innovative approach to staff development formed as a cooperative arrangement between Indiana University and several rural school corporations and agencies. The program uses a distance education delivery format facilitated by interactive microcomputer and communications technologies to provide a wide range of on-the-job training activities to teachers in rural communities.

Background

Over the past four years, the Indiana University Department of Curriculum and Teacher Education has been developing and delivering a series of seven training modules to teachers in rural communities via distance education technologies (see Knapczyk, 1990, for a detailed description of the program). The content of the training modules deals with designing, implementing, and evaluating interventions for children with learning and behavior problems. Each module focuses on a different skill area that may pose some difficulties to a particular student or group of students in the teachers' classes. The topics of the modules are as follows:

Module 1: Determining the expectations for successful performance in school and community settings.

Module 2:	Assessing student performance and designing individualized intervention plans.
Module 3:	Improving academic achievement and cognitive skills.
Module 4:	Improving participation in instructional activities.
Module 5:	Improving social skills.
Module 6:	Improving organizational strategies and study habits.
Module 7:	Improving self-management and motivation.

Teachers enrolled in the program complete the requirements of each module by participating in a large group class session and a supervised practicum activity. During the practicum, the teachers apply the techniques and strategies discussed in the formal class to their own classrooms. Each selects one or more students who are having difficulties in their class as part of the course project. They then conduct an informal assessment of the students, and design and implement an intervention to help address the students' difficulties. The teachers are expected to provide detailed weekly reports of their work to a faculty or graduate student trainer at the university, who in turn provides written feedback to the teachers on their work. In addition to meeting formally with the trainer once a week, teachers also meet in small school-based cohort groups to assist each other with the work required in the program.

Enrollment into the program is based on the interest of communities of teachers. When a new training site is established, the location is selected because *groups* of teachers from area schools have demonstrated interest in the program. In each of the modules teachers are expected to meet in small school-based groups and are encouraged to discuss their ideas and problems with teachers from other schools.

In this way, a single teacher will not be isolated from all the other teachers involved in the training. The teacher will have several other teachers from the same school with whom to consult regarding content of the program, assignments, and problems.

Seven training sites have been established throughout the state, and about 40 teachers have competed the training thus far. Approximately 40 more teachers from eight different school settings are currently enrolled in the program. The settings include one preschool, three elementary schools, one middle school, and three high schools.

Current technology used to deliver the program

All of the training is delivered to each site using distance education; that is, the trainer and the teacher-participants are "[quasi-permanently separated from each other] throughout the length of the learning process" (Keenan, 1990, p. 44). In fact, the teachers only meet with the trainer face to face approximately twice each semester. Thus, technology plays a major role in the delivery, monitoring, and evaluating of the entire program. Currently, audiographics, fax machines, and teleconference phones are used to handle the delivery and monitoring of the program (see Table 1). Each of these technologies is described below.

Audiographics. Audiographics is a computer-based technology that permits transmission of graphical images over telephone lines (Knapczyk, 1990). In addition, an audiographics system allows individuals at different sites to annotate images on their computer screen with either text or rudimentary graphics (e.g., underlines, circles) and have these annotations simultaneously appear on the other site's computer screen. In distance education classes,

Table 1
Hardware and software used to deliver teacher training program.

Product Name	Description	Vendor
6300 microcomputer	8086-based computer with 20 megabyte internal hard drive and 1 megabyte of RAM.	AT&T
OverView scanner	Gray-scale overhead scanner.	AT&T
Bridge modem	4800 baud internal modem.	AT&T
Scanware software	Audiographics software	AT&T
Quorum conference phone	Conference phone with jacks for external microphone and speaker.	AT&T
3510 fax machine	Thermal paper fax machine	AT&T

audiographics allows a computer to become an "electronic chalkboard" where both the students and the instructor can place information for everyone to see.

The audiographic system used in this program requires a DOS-based personal computer at each site. The audiographics software was developed by AT&T, and requires at least a 4800 baud modem and two megabytes of disk storage. However, only 640 kilobytes of RAM are needed to actually run the software. By using a gray-scale scanner, trainers can scan images developed for the class into their computer's memory and, using the audiographics software, quickly transmit the visuals to the distant site.

Fax machines. Fax machines are used by both the trainers and the trainees to transmit documents between the university and the training sites. Teacher-trainees are required to develop case studies as a part of the course, and they transmit rough drafts of their case studies to a university trainer using the fax machine. The trainer then looks over the trainee's work, adds comments and feedback, and tranmits the work back to the trainee for revision.

Teleconference phones. In both the large- and small-group meetings, teleconference phones are used to link university trainers to the trainees. These phones allow for vocal interaction and discussion among multiple sites. Sensitive microphones are connected to each phone, thus making it easier to pick up softer voices or voices that are farther away from the phone.

During a large group session, a teacher-trainee at one of the training sites uses the teleconference phone to establish a voice link with the university. Then, a second telecommunications link is made between the computer at the university and the computer at the training site. The computer link is established to transmit the visuals between the university and the training site using the audiographics software.

Difficulties with training over distances

The technology used in this program has worked adequately thus far to fulfill the delivery, communication, and evaluation needs of this distance education training program, but there are areas where the system could be improved. First, university trainers have experienced limitations in their ability to provide feedback using the present system because teachers send their reports in handwritten form, and trainers must either write their evaluative comments and suggestions on the fax paper and try to send a usable copy back to the teacher, or write comments on a separate sheet of paper, thus having to recreate the context of the teacher's report so that the teacher understands to what sections of the report the comments are directed. Second, the project designers thought that teachers involved in the training experience would provide assistance to each other even if they were employed at different schools. That is, since teachers across schools tend to face similar challenges in working with children who are at-risk or mildly handicapped, giving teachers a means of sharing problems and solutions across schools and districts was assumed to be beneficial. So far, these groups have not established relationships with one another because there is no efficient way to connect the technology across training sites. Audiographics are good for large group meetings, but for one-on-one communications or discussions among a small number of teachers, establishing an audiographic link takes too much effort. Third, once the training is completed the teachers involved in the training are cut off from any further professional assistance they might want or need from experts at the university. Their only method of contacting their university trainer is by telephone, and this is a hit-or-miss process since the trainer may not be available when a teacher calls. In addition, maintaining a connection with the university would provide teachers with access to university library resources and technical expertise, thus giving them additional information and resources to assist with their teaching.

In order to enhance the program and provide the additional features to both trainers and teacher-trainees, new methods were needed to better facilitate the exchange of ideas and feedback between university trainers and teachers, and among cohort groups of teachers. Audiographics, fax machines and teleconferences, while providing the basic technological structure for implementing a field-based training program, were apparently not providing the base for dynamic interactions between teachers and trainers. Teachers were sharing their work with only small numbers of peers, all of whom were working in the same school, and trainers wanted more efficient methods for providing feedback to teachers on their work.

Enhancing the program

Using these problems as a focus for improving the training program, the designers decided that an enhanced electronic communication tool would be appropriate. One idea was to incorporate the electronic mail system currently available through the university. The university's electronic mail system would provide teachers with a basic messaging system, and give them access to the university's on-line library catalog. This was attempted, but teachers and trainers soon found the system too complex to use. Remembering a series of five or six steps to log on to the mail server proved too cumbersome for the teachers and trainers. Also, using the university mainframe to provide feedback to teachers on their case studies required elaborate upload and download procedures to transfer the information between sites. No one participating in the program felt that this was an adequate solution. Teachers and trainers needed to transfer information as easily as they did using the fax machine, and the information had to be in a form that was easier to edit than printed text on fax paper. Furthermore, participants from different schools needed to communicate ideas and concerns with one another and have the information presented in a usable format. Documenting ideas shared over the telephone was difficult. Thus, an integrated set of communication and information access tools had to be developed to meet the needs of the professionals involved in the program. This set of tools, collectively called "Teacher Training Mail" (TT-Mail), combines an easy to use graphical user interface with communication and word processing applications, thus providing users with a simple yet powerful device for professionally collaborating with one another over distances.

Description of TT-Mail. TT-Mail was specifically designed to help teachers, and teachers and trainers, electronically collaborate with one another. It is a performance support tool developed using a combination of software products (see Table 2). The structure for the user interface was developed using *HyperPad*, a HyperCard-type of product for character-based DOS machines. This product had to be used for most of the development since the computers used by the various schools involved in the project were low-end personal computers (8086 based), and *HyperPad* was the only development tool that would provide the basic structure for an electronic collaborative environment that could also run on the machines available at the schools. Electronic communication among computers at the training sites was handled through elaborate scripts written using *Procomm* communications software. *WordPerfect* was chosen as the word processor for teachers and trainers to use to develop their case study reports and to provide written feedback. Each of the products mentioned above performed a unique and necessary function in the process of providing teachers and trainers the ability to easily exchange information over distances. The combination and integration of these products allowed participants to send and receive text messages and attach formatted word-processed documents to their messages.

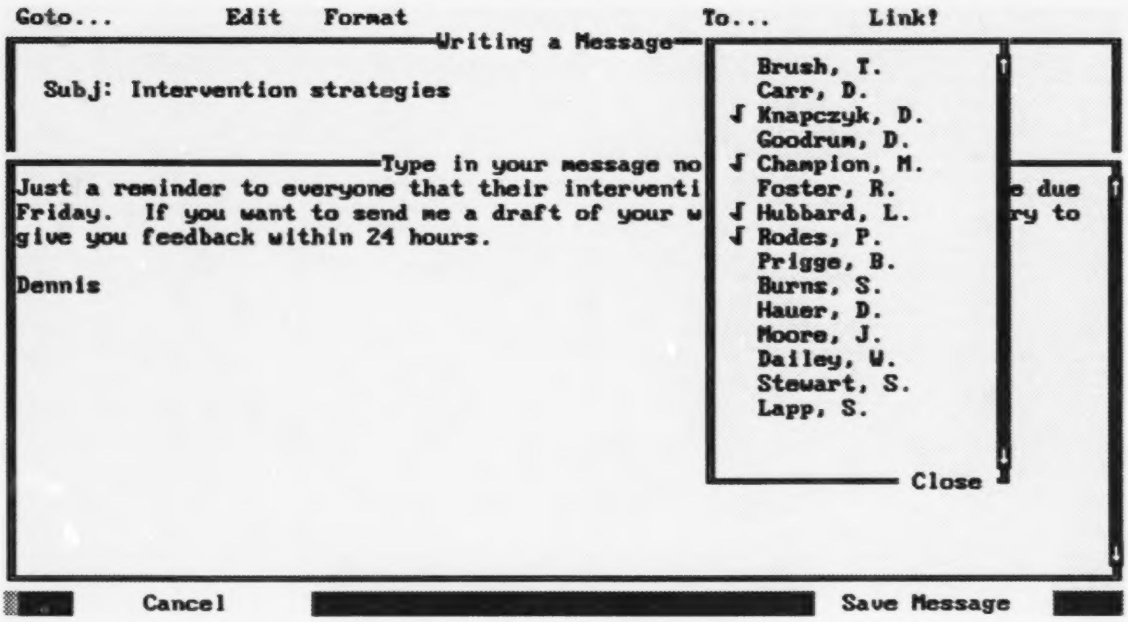
Sending messages to other participants using TT-Mail is a simple matter of choosing to whom to send the message, writing the message, and clicking a button (see Figure 1). TT-Mail handles all of the communication access and file transfer protocols automatically. To receive messages, users simply insert their personal disk into the computer and type in their password. Their messages are automatically transferred from a temporary storage space on the school's computer to their personal disk. To read a message, a user chooses from a list of messages stored on the personal disk. The selected message appears in a new window. From this point, the user can reply to the message, forward the message, delete the message, move the message to an electronic folder, print the message, or look at other messages (see Figure 2).

Using this electronic message system, teachers can easily communicate with their colleagues at other schools and stay in contact with faculty members at the university. Once the training program is completed, teachers still have the means to discuss problems with other teachers or university professionals, and continue to have access to university resources such as the online library catalog. With TT-Mail, teachers can share ideas with other groups of teachers, provide suggestions, and easily view and manipulate any information they receive.

Sending word processed documents requires little more effort than sending text messages. When users are ready to send a document, they select it from a list of documents on their personal disk. TT-Mail then automatically converts the document from its current *WordPerfect* format to rich-text-format (RTF). With this process, the document is easier to transmit, and all of the

Table 2.
Software used to develop TT-Mail

Product Name	Description	Vendor
HyperPad	Interface development toolkit similar to HyperCard.	Brightbill-Roberts
Procomm	Communications software	Datastorm
Software Bridge	File conversion utility	Systems Compatibility
WordPerfect	Word processing software	WordPerfect Corp.



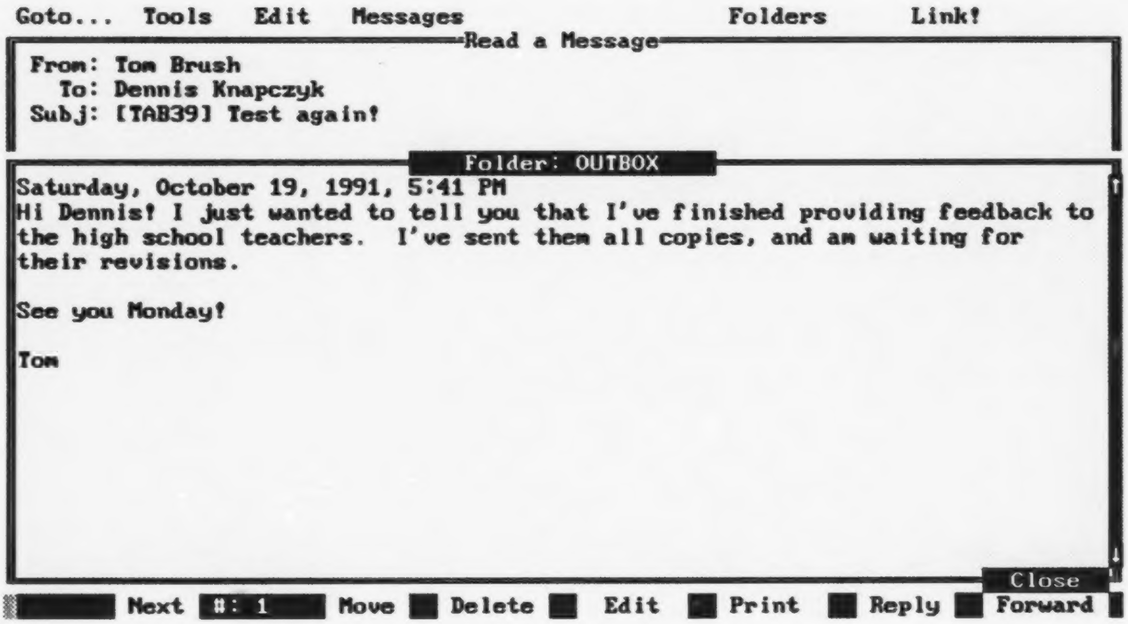
Subj: Intervention strategies

Just a reminder to everyone that their interventi … e due
Friday. If you want to send me a draft of your w … ry to
give you feedback within 24 hours.

Dennis

Brush, T.
Carr, D.
✓ Knapczyk, D.
Goodrum, D.
✓ Champion, M.
Foster, R.
✓ Hubbard, L.
✓ Rodes, P.
Prigge, B.
Burns, S.
Hauer, D.
Moore, J.
Dailey, W.
Stewart, S.
Lapp, S.

Figure 1
Writing a message using TT-Mail



From: Tom Brush
To: Dennis Knapczyk
Subj: [TAB39] Test again!

Saturday, October 19, 1991, 5:41 PM
Hi Dennis! I just wanted to tell you that I've finished providing feedback to the high school teachers. I've sent them all copies, and am waiting for their revisions.

See you Monday!

Tom

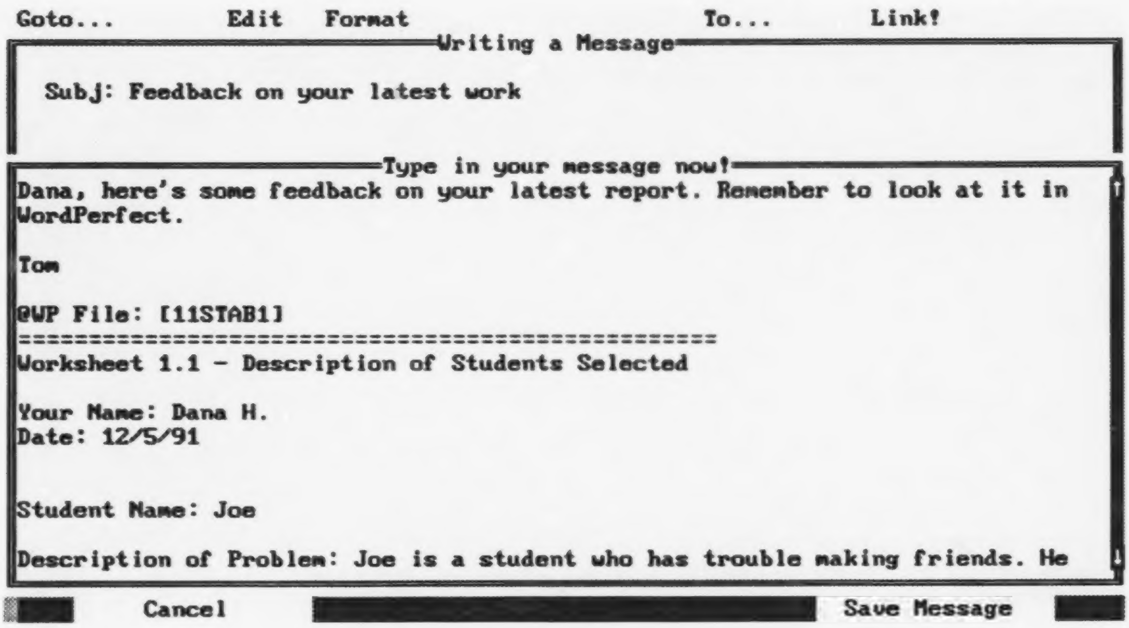
Figure 2
Reading a message using TT-Mail

formatting (e.g., underlining, boldface, and italics) is kept intact. TT-Mail will attach the selected document to the current text message they are writing, and send the document and text message together. Thus, the process of sending a word processor file to another user or group of users generally involving complicated upload and download procedures has been pared down to selecting a document and clicking a button (see Figure 3).

To read a word processed document, the user extracts the document from the text message. This involves selecting the file name of the document (which appears on the screen when it is viewed in TT-Mail) and clicking a button. The document is extracted out of the TT-Mail message, converted from RTF to WordPerfect format, and shown using *WordPerfect* (see Figure 4).

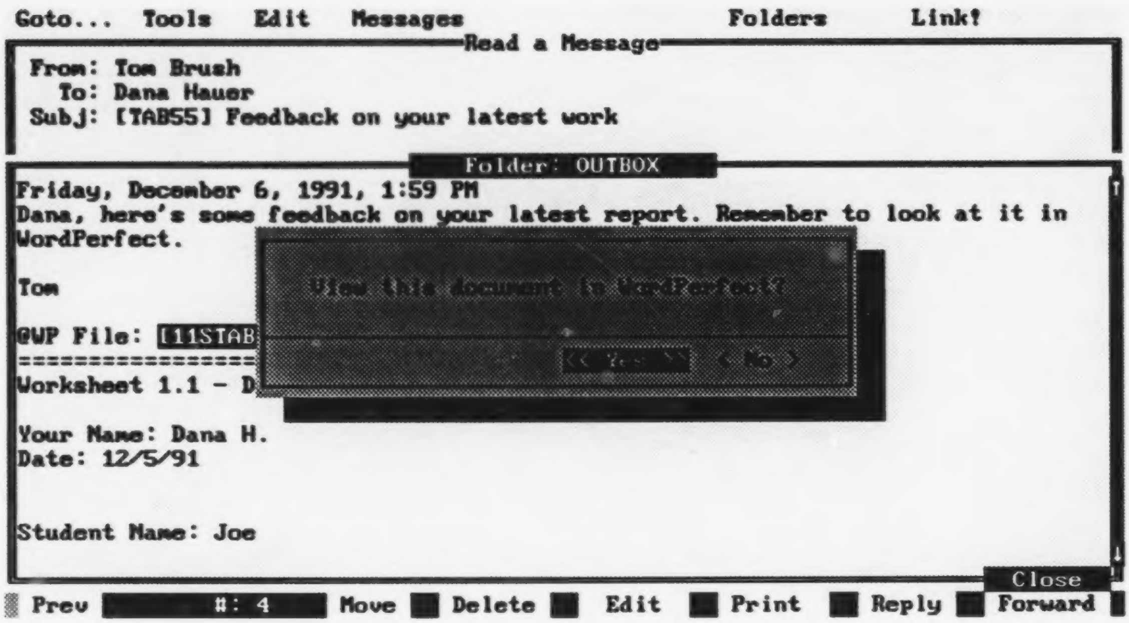
By using a word processor and TT-Mail, teachers are able to send documents to their university trainer as easily as tranmitting the documents using a facsimile machine. This process provides both the teachers and the trainers with editable copies of the teachers' work. Thus, the trainer can easily add comments to a word processed document and send it back to the teacher for revision. Using a facsimile machine, the trainer had more difficulty attaching comments directly to a teacher's work, and a teachers could not make the revisions to their work without crossing out information or rewriting the work. Also, faculty mentors receive the teachers' work at their desk instead of having to go into the fax room and sort through a large number of documents to find the correct ones.

TT-Mail was designed to replace some of the tools currently used by the program. For example, participants using TT-Mail no longer need to fax information to one another since they can electronically transfer a more usable copy of their material . In addition, TT-Mail can be used to replace the audiographic system currently in use. The trainer can transmit electronic copies of the visuals for the class prior to the formal class meeting. Then, during class, teachers can display each document on their computer as the faculty mentor refers to it. This method is more cost-effective than the current method of transmitting graphical images of the visuals because the program requires that two phone lines be installed at each training site: one for voice communications and one for data transmission. Using TT-Mail, one phone line can be used for both voice and data transmission since voice and



```
Subj: Feedback on your latest work

Dana, here's some feedback on your latest report. Remember to look at it in
WordPerfect.

Tom

@WP File: [11STAB1]
==================================================
Worksheet 1.1 - Description of Students Selected

Your Name: Dana H.
Date: 12/5/91


Student Name: Joe

Description of Problem: Joe is a student who has trouble making friends. He
```

Figure 3
Sending a word processed document using TT-Mail



```
From: Tom Brush
  To: Dana Hauer
Subj: [TAB55] Feedback on your latest work

Friday, December 6, 1991, 1:59 PM
Dana, here's some feedback on your latest report. Remember to look at it in
WordPerfect.

Tom

@WP File: [11STAB
================
Worksheet 1.1 - D

Your Name: Dana H.
Date: 12/5/91


Student Name: Joe
```

Figure 4
Reading a word processed document using TT-Mail

data information do not have to be transmitted simultaneously.

TT-Mail is currently used by a small number of teachers as well as by the university trainers. Initial reactions to the tool have been favorable, and more formal evaluation of the tool will occur in the next few months. Barring any unforeseen problems, when the next training site is established, TT-Mail will be an integrated part of the program.

Summary

Delivering a training program to practicing teachers via distance education requires a variety of technological enhancements to the traditional delivery and monitoring system. In this program, we have found that no single product has provided us with all of the necessary enhancements. By using a combination of audiographics, fax machines, teleconferencing, and innovative messaging and document transfer tools, this training program provides teachers with a unique experience within their own schools. Teachers can receive useful training without having to travel to the university, and can apply the concepts used in the program immediately in their own classroom situations. Furthermore, teachers work together with other teachers from their own schools and other schools, and maintain these professional relationships after the training program is completed.Thus, we feel that delivering this program through distance education enhances the effectiveness of the program rather than limiting it.

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A Shared Vision For Teacher Preparation And Professional Staff Development

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Abstract

This paper addresses issues embedded in the challenges of providing appropriate training for both preservice teachers and inservice teachers. The impetus for training of faculty and students at both high school and college levels is related to elements of school reform and school change.

Related readings are reviewed and project structure and first year of operation are discussed. The uniqueness of a long time direct relationship between a public high school and the School of Education in a nearbly college is highlighted. Areas of success are discussed and plans for years two and three are outlined.

Related Reading

Elements of School Reform

Today's often crowded and underfunded high schools are under scrutiny as no generation before them has been. Such scrutiny has focused on all segments of the school: students, teacher, principals, time in school, time on task, which techniques are used in the classroom, and how they are delivered. Debate of the past several years has often focused on questions not only of what to do, but to whom? Dutiful readers who wish to assess the total picture will soon be inundated with the proliferation of reports from agencies, commissions and committees appointed by national organizations, the President of the United States, governors of various states, several businesses of national/international stature as well as a group composed of the deans of noted universities throughout the nation.

Arguments have been provoked, not only among the general public and the politicians they have elected but also in the professional education community. Good and Brophy (1986) comment: " . . . the National Commission on Excellence in Education called for longer school days. However, one wonders how more time ipso facto can improve teaching and learning in American schools. . . . calls for a longer school day in all schools because some schools need more time is a silly and costly educational prescription that will do as much harm as good" (p. 575).

Voters and School Boards alike have responded with negativity to such costly, out of hand suggestions. But professionals must wrestle with the reality of day to day involvement and object to some of the spinoff results of this series of national level reports. Such frustration is addressed again by Good and Brophy (1986) "Although reports like *A Nation at Risk* have been enormously successful in generating public interest—and potentially public support—for education, they have also shifted the debate on schooling from issues of quality (what teachers and students do in classrooms to allow for understanding and application of important knowledge) to the search for standard and immediate answers (more graduation requirements)" (p. 575).

And as the discussions continue, so do the students—graduating by the hundreds of thousands—each spring. In other words, the business of schools, teaching and learning proceeds. But one encounters a growing phenomenon within educational circles: a rising concern about the various components of the educational environment. One of the most potent forces on the educational scene is media. How media are used in the classroom, rather than whether and when to use various forms of media, seems to be the question.

A Focus for School Change

External forces influence what happens in the schools. The most obvious pressure group is the parents of children in the school system. Cuban (1986), in his writings about *Teachers and Machines*, identifies many forms of media that have been a part of the classroom for years, but points to the pressure exerted by parents and other segments of society for the use of the most recent arm of technology. He notes that "concerned parents gave micro computers to schools, a clear signal to the principal and teachers that the machines were to be used with children. Thus, much of the drumbeat for instructional use of computers came from outside schools" (p. 76).

Having recognized the need for reform, school personnel found in the question of media a focus to the inevitable question, "Where do we begin?" Researchers had already stirred some provoking thoughts that addressed concerns in the classroom. In their discussion of *Media in Teaching*, Clark and Salomon (1986) raise a series of questions that provide an interesting framework. In their rather historical perspective of the use of media in teaching, they summarize their concerns about the lack of research focused on media: "Although media often were not the focus of study, the results were erroneously interpreted as suggesting that learning benefits had been derived from various media" (p. 465).

The assumption here is that the focus of learning must remain on the content and we must not be dazzled by the actual medium used to communicate. This is easy enough when the medium is the chalkboard (of whatever color) or even the audio tape, but who could not appreciate the photography of a spectacular view portrayed on a slide and projected in a larger than life fashion. Who could fail to be awed by the addition of movement and of sound in a skillfully produced motion picture focusing on plant development or any other of the numerous topics presented in today's classrooms? Even so, one might question the kinds of benefits that will accrue from the use of specific media.

Consideration must then be given to the audience to be addressed—in this case, the learners. What learning will occur as a result of using this medium? How will the material be received? What will be the most effective format for this medium? These are basic questions good teachers ask themselves every day. Clark and Salomon (1986) reinforce this concern in their discussion of the *perception of the learners* and how those effects came to be. Additionally, they speak to the case for variety as well as for the involvement of the learner: ". . . the way one perceives media influences the way one treats them. Nor, however, are learners the sole power brokers, for their perceptions are founded on the kinds of media they actually encounter and activities they are actually afforded" (p. 473)

Today's audience of learners houses not only the uninitiated in the use of modern media, but the champions of the local video games, many of whom will have their own extensive library of games for they have found tremendous involvement or interaction in these activities. In this climate of the modern media, the personal computer, is the teacher likely to be the expert? Probably not. The opportunities for the use of such media are likely to have been meager, unless the teacher has actively sought such instruction.

Teachers do bring to the forum a concern for appropriate learning in the classroom. Deeply imbedded in the question of appropriateness is the belief of the teacher about what really should happen in the classroom. Dwyer, Ringstaff and Sandholtz (1991) recently shared their observations from the Apple Classroom of Tomorrow project: "... the teaching staff brings to the classroom deeply held beliefs about schooling. These beliefs were ingrained in the traditional classrooms where they spent years, first as students and later as teachers. What we found is that the more things change, the more teachers must confront their beliefs about learning and the efficacy of their instructional activities" (p. 46).

In Summary

We see three basic questions that have developed as a focus for change:

1) When, how and what is the appropriate medium to use in the classroom?
2) If the choice is the personal computer, how are students and their learning affected by this choice?
3) Should all teachers be using this approach and, if so, what influences their decisions and manner of use?

Components of the Vision

Overview

A three year program was proposed to address the needs of faculty members and students at Sprague High School in Salem, Oregon and Western Oregon State College, Monmouth, Oregon. Basically, four specific goals were identified; needs clearly existed in the follow-

ing areas:
1) training in the use and application of computer technology for both in-service and pre-service teachers;
2) implementation of technology into the classroom to be carried out by whomever felt ready—in-service teachers or pre-service teachers;
3) an environment of continuing support for all teachers to ensure that classroom technology would become a reality; distance communication was thought to provide this link;
4) what was done should be useable by all and therefore we should think in terms of how others could use what we learned.

A team approach to computer training was needed for high school and college faculty to become comfortable with the concept of using the computer in classroom instruction. The assessment was easy: the demonstrations of software and hardware were faithfully attended by faculty. They asked intelligent questions, looked interested, and said "That's nice", and went back to their classrooms. In most cases they remained uncontaminated by any type of computer related instruction.

Each faculty is made up of very active, professionally involved teachers. Some are using software to maintain grades and perform other record management tasks. But outside the specific classes in programming or computer applications, students seldom were required to see or use any computer on either campus.

The Partnership

Sprague High School, one of five high schools in the Salem-Keizer School District, and the School of Education at Western Oregon State College, one of the eight institutions that form the Oregon State System of Higher Education, have a long and enduring partnership. Plans for the partnership were drawn during the first year of the school's planning and development and were implemented upon the opening of Sprague in 1971.

The college coursework was to be conducted in a classroom on the high school site. Students entering the Education program at Western would then be involved in one of the high school classrooms for two class periods to get a first hand look at the realities of their chosen profession. This continuous partnership now provides a working laboratory for those students in the newly revised Teacher Education Program at Western.

Sprague faculty members seeking coursework for advanced certification often participate in graduate level courses at Western. Some Sprague faculty members are adjunct faculty at Western; many give generously of their time to answer questions posed by neophytes who are interested in how it feels to be evaluated by the principal, write lesson plans, decide on which teaching method to use and how to organize grade books.

This partnership submitted a proposal titled Teacher Preparation and Enhancement in the Use of Available Technology; when the proposal was funded, IBM became the third and enabling partner.

Confirming the Need for Teacher Preparation in Technology

Three major surveys in the late 1980s speak to the issues of teacher need in the area of technology. The National School Board Association's 1988 poll of 773 school superintendents found that over half of those surveyed believed that *technology made instruction more effective*. A report by the U.S. Office of Technological Assessment was issued in 1988. Among their findings was that the *majority of those persons teaching or planning to teach have little or no computer education or training*. In 1989, the Wirthlin Group conducted a nationwide telephone survey for IBM of 1100 pre-college teachers. Significant findings announced were:
1) 91% of the teachers interviewed felt that computers could help students develop basic skills;
2) 86% believed that the use of computers promotes students' problem-solving abilities;
3) 87% believed that the use of computers helps students develop greater self-confidence;
4) 86% felt that computers could help them "unlock the creative potential of students"; and
5) more than half agreed that teachers are inadequately trained in using computers for instruction.

Teachers need help in order to assist their students in the learning process. IBM Vice President, Lucie J. Fjelstad (1991), explains, "The problem is not that our schools have gotten worse—but that our needs have multiplied. About every three years, society's knowledge base doubles. Young people are required to process more information—and increasingly more complex information—than ever before, as well as to grasp new and rapidly changing technological skills" (p. 17).

The present situation in the former Soviet Union is a spectacular example of rapidly changing information; during the past 18 months social studies teachers who completed plans one afternoon for the following morning's class on Russian studies were likely to come to class to find those plans were outdated and inaccurate based on events in that country during the intervening12 to 18 hours. How does the teacher deal with this situation? The conclusion becomes clear: it is no longer possible for the teacher to be the all knowing source—the provider of information. The role of the teacher must change if the teacher is to be effective and if the learner is to gain an ability to survive in today's world.

In a recent lecture to pre-service teachers, Barry Jahn (1991) at Sprague High School reiterated that "teachers will have to wade through and evaluate the information available . . . the skills we will need to teach are how to search for relevant information, how to refine and evaluate it and how to process it."

The Facilities

Sprague High School

The computers provided by the project were placed in the Media Center. The networked lab was in a low traffic area near the offices of the Center Director. The lab is dedicated to the use of curriculum based projects only, although other students may use the computers not in use by the class occupying the lab. By dedicating this particular lab as the curriculum lab, it became clear to the faculty that they would need to plan when and how they wanted to use it. The first year was not totally booked every period, so students were allowed to use it at open times.

As teachers gained more skill and confidence they began to want more time and were able to use it to advantage. By the fall of the second year the Center Director and some advanced students collaborated to write a scheduling program so that teachers could reserve a three day, three week, or eight day block of time. The available software was appropriate for a variety of classes such as English and Social Studies, for example.

Western Oregon State College

Project hardware was placed in the curriculum lab in the Institutional Technology Center (ITC) on the college campus. These facilities house the Educational Media Program, including classrooms, and the curriculum collection that serves the secondary and elementary education programs on the Western campus. A component of this collection is a library of software, and all the software from the project was placed in this library. The hardware is nearby in a small reviewing area so that the attendant at the desk can assist students when they need help. The lab hours, 8:00 am. to 10:00 p.m. weekdays, with shorter time lines on weekends, allow ample opportunity for pre-service and in-service teachers to review materials they may wish to use in the classroom. The lab is open to any teacher or school employee who wishes to make arrangements to review specific software. As this service has become more widely known the use has continued to increase. Though the hardware is not extensive in this location, the extended hours allow time for most teachers who wish to use the facility.

The Program

Obviously the two groups (pre-service teachers and in-service teachers) represented in this program will take different paths to reach appropriate levels of preparation and enhancement in the area of technology. The uniqueness of this program is the interaction of the two groups, who along with the high school students, are learning to help each other to reach a common goal—that of positive use of the available technology. It is quite common to observe the interaction in the lab without immediately locating the actual teacher. The students all help each other with the questions that arise; if they can't solve the problem, then the teacher is called in for consultation. This allows the teacher time to work with individuals and to solve problems with all groups.

The use of an agreed upon training continuum was helpful. We knew that learners would enter the training cycle from a wide array of skill levels The continuum was divided into three levels of computer use: awareness, routine or deliberate use, and innovative use. No pressure was placed on participants to plan to move from one level to another—whether this became a goal was the decision of the learner.

Training for the pre-service teacher

As in many institutions, students at Western Oregon are required to take a computer course in their lower division work. It is at an introductory level and is designed for the student with very little previous work on the computer. Students who have some experience are encouraged to seek a computer class that will provide them with an opportunity to gain more skills in this area. This course is required of all students in all areas of study across the campus; thus it is a very generalized study.

In the professional core, secondary education students are required to take a course in educational technology, which includes a review of various media as well as use of the computer in a lesson they will provide students at their practicum site. Students use the opportunity for instruction at the level they feel they need. Students in the pre-service program doing their practicum at Sprague could well find themselves acting as assistants to both students and teacher in the curriculum lab if their skill level is appropriate. Others less skilled or less confident are welcome to become students if their class is in the lab or if they have extra time to spend time at computers not occupied by other class members. Students may also take any of a dozen or so classes offered at various levels on campus. Coursework offered at night at Sprague High School is also open to them.

In-service teacher enhancement

Teachers have a number of options in gaining experience on the computer. Sources of funding other than the grant are available to support coursework. Coursework is also offered on site in the evening and is also available at the college. Many who are new at the process simply want time to sit and use the computers to gain greater skill, review the software that is available to them for use in their courses, or help students who need extra practice.

College faculty have tapped faculty development funds in order to gain time to review new software. They also invite guest speakers from the Educational Technology faculty to maintain student awareness of developing technology.

Summary

Accessibility is, of course, of prime importance in this situation. Given the opportunity, we have seen in-service teachers and pre-service teachers alike stretch to get in step with what they see as important for their students. Ryan and Cooper (1988) confirm our beliefs when they comment on the condemnation of education attributed to G. B. Shaw that "those who can do, those who cannot, teach": "The world has taken a lot of turns since Shaw wrote that line. Education is no longer a luxury of the leisure class. Teaching is much more demanding and crucial . . . than it ever was before. Developing a person's human potential is serious work. Now those who can, teach" (p. vi).

The Vision Takes Form

Meeting the Goals

The levels of use continuum

The first goal utilized the levels of use continuum and focused on providing training for both pre-service teachers and in-service teachers. A very broad range was expected and this indeed was the case. At one end of the continuum are the persons that Clark and Salomon (1986) describe as having negative attitudes and high anxiety levels towards computers that are related to poor attitudes toward math and science. They conclude "It would be interesting to study how the perceptions and attitudes of computer users guide their strategies for learning from computers, how these different strategies influence learning, and how work with computers changes or maintains these perceptions reciprocally" (p.472).

At the opposite end of this continuum is the teacher who is constantly searching for the exact and proper way to teach specific content. Fenstermacher (1986) alludes to this type: "...education is undertaken to liberate or free the mind. It is education that requires more than subject matter mastery; it requires the manner of a liberated person. To liberate the mind of another the teacher must know how to teach in a manner that liberates as well as know the subject matter to be taught" (p. 47). Because they often view technology as a tool useful to their students, this contemplative type of teacher may be the one who seeks additional training for personal education. In this program training opportunities must be available for all three levels of computer use—not only for the beginner but also for the teacher striving to move toward encompassing and using the developing technology in the classroom.

Implementation

The process of implementation also addressed a number of different stages at both the pre-service and in-service level. More advanced learners evaluated the software and made recommendations to their peers for their use. For example, one English teacher early in the first year chose to use her writing class as a pilot for the department. She was successful and was able to report back to her peers how it was organized; students themselves wrote about what they had learned. They listed writing skills but also added comments on learning to collaborate and improving their keyboarding skills. This finding agrees with observations by Dwyer, et al. (1991) from their "technology rich classrooms": "At both elementary and secondary schools, teachers saw their students move away from competitive work patterns toward collaborative ones" (p. 47).

Years Two and Three

Plans for telecommunications are moving in a positive direction. The development of an environment of support continues be enriched despite threats of external problems in financing the larger education arena. The imminent extension of electronic communication between the two campuses keeps people enthused and involved at each stage. The plan to share findings through a promising classroom practices database is being aligned with the changes in statewide curriculum and will be articulated as the content areas are developed.

Recommendations for Sharing the Vision

Extensive recommendations are not yet available for various reasons, including staffing changes in the School of Education as well as at Sprague High School. While we value highly the skills and contributions of our new colleagues there is need for orientation and reassessment. The results however, have proven to be well worth the time and energy expended.

The training continuum has been highly successful from the perspective of how people who chose to participate have worked together. We like the words used by Prothro (1991) to describe this process: "Success means getting your message to the right audience at the right time—theirs" (p. 132). We trust that all of our participating colleagues have found the challenge as invigorating as we have found it to be.

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Providing Inservice Computer Training for Teachers During the School Day

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Phyllis McCraw
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Abstract

Providing inservice computer training during the regular school day in a rural school, while well received by teachers, is not without problems. Included in this paper is a discussion of the goals and objectives of an inservice computer training program, the success of meeting these goals, the problems encountered, and how they were overcome.

Introduction and Significance

Providing inservice computer training and technical support that is relevant to the classroom teacher is a first step to integrating computers into the classroom curriculum. Without training and support, computer use in the average classroom will continue to be little more than a filler activity. Sturdivant (1989) identified 10 obstacles that were faced by the Houston Independent School District in encouraging teachers to use computers with their students. Of these obstacles, the following were identified as relevant to the school setting in which we implemented computer training: lack of teacher incentives, limited time for staff development, limited opportunities for teachers to observe model applications, teacher isolation with few opportunities for sharing, limited software and computer access, lack of assistance, and lack of feedback and direction. Persky's study (1990) recognizes these obstacles, particularly the need for technical and emotional support as teachers try to integrate the use of computers in their class curriculum.

Glenn and Carrier (1989) state that technology inservice is important because the majority of teachers currently teaching in schools have had very little, if any, technology training. As a consequence, they have not used the computer or any advanced technology in the classroom, and they further find that few teachers will take the initiative to seek additional technology training or education.

Fulton (1988) maintains that the most crucial factors in giving teachers an opportunity to develop competence and confidence in using computers are time and support . Alifrangis (1991) also recognizes time as a factor necessary for teachers to develop competence in using computers in an educational setting. She found that, in spite of their good intentions, "teachers rarely sat down and went through the various programs themselves. Without this background information, they cannot easily integrate the [programs] with those in the classrooms; they cannot anticipate difficulties the students might have and thus, better prepare the students for those particular programs; and they cannot offer productive ongoing assistance" (p. 60). In addition to lack of time, Kimpston (1990/91) identified lack of communication among teachers, computer coordinators, and administrators as a major obstacle to computer use.

Methodology

Data were collected through:

1. Semi-structured and unstructured interviews with the principal and teachers.
2. Direct daily observations of teachers in the computer lab.
3. Baseline questionnaires and interviews with the teachers to capture their philosophies of education, their perceptions of the role of computers in education, their views of how students learn, and the extent of their knowledge of computers.

Data collected from observations and interviews were triangulated to provide a full description of the research environment. Pseudonums were used to maintain, as much as possible, the anonymity of the principal and teachers.

Framing the Case

In August, 1991, two rural schools jointly received a one year Small Schools Cooperative Grant from the state of Oklahoma for the implementation of a computer program. The $35,000 grant was intended to improve students' problem solving and critical thinking skills through the use of computers. The grant money was allocated for the purchase of hardware, software and the employment of a computer coordinator.

The original goals of the grant were written by the Quaint City principal as follows:

1. To teach computer skills to the elementary students at Quaint City and Farther Out.
2. To increase the students' exposure to and experience with computers.
3. To give students practice using critical thinking and logical thinking skill which will be used in learning how computers work (think).

From the goals. the principal derived the following objectives:

1. Students will demonstrate a statistically significant gain in computer skills as measured by a pre and post test.
2. Students will increase the time they spend working with a computer from approximately one quarter hour per week to one and one quarter hours per week.
3. Students will demonstrate statistically significant gains in critical thinking as measured by the following appropriate instrument: (a) Cornell Critical Thinking Test (b) Creative Reasoning Test by John Doolittle (c) Classroom measures of student's ability in computer logic (thinking).

The principal proposed curriculum activities for the grant were :

(a) Keyboarding; (b) basic computer operation (on/off, loading programs, saving data); (c) Information processing; (d) Output (producing work with the computer); (e) Logo programming; and (f) beginning programming.

McCraw, an instructional designer, was hired to develop a computer program for both the Quaint City and Farther Out schools. Because of the different principals and structures of the two schools, only the Quaint City school computer program will be discussed in this paper.

The Quaint City school faculty is comprised of16 female teachers and one male principal. The student body consists of 250 students. In the initial meeting with the Quaint City principal, McCraw concluded that while the principal was aware of the benefits of students using computer applications, he had an incomplete perception of software integration. Although he understood the necessity for training teachers in the use of computers as a first step to software integration, he had not considered how that need could be met. McCraw suggested meeting the teacher training need in conjunction with the lab. Quayle was supportive of this procedure.

Based on McCraw's recommendations, the original grant goals and objectives were expanded to include basic computer education for the teachers. The program was developed based on two goals:

1. Teachers would be able to effectively use the computer lab after the Instructional Designer's one year term was finished.
2. Teachers would be provided inservice computer training within the framework of the school day.

These additional goals were broken down to include three instructional objectives:

1. Teachers would learn functions and operations of the Apple IIe and IIgs computers.
2. Teachers would be able to utilize computer tool applications for personal productivity and student instruction.
3. Teachers would be able to evaluate and select software that was well designed and would meet class curriculum objectives.

The method of instruction selected to accomplish the additional objectives was dubbed "School Day Inservice." This meant that teachers would be given basic computer instruction in the computer lab by the coordinator during the time their students attended computer classes.

Implementation of School Day Inservice

A meeting with the elementary school's five member computer committee and the instructional designer/lab coordinator was arranged by the principal. The intent of the meeting was to enlist the cooperation of the committee regarding inservice computer training for all teachers in the school. Prior to the meeting, the coordinator had compiled a catalog of the school's software to be distributed to the committee members. The catalog documented the subject, the grade level and a cursory description of each software application. It was used by the coordinator as a vehicle to put information in the hands of the staff and begin gaining their trust and support for the program.

During the computer committee meeting, McCraw proposed that teachers would have an opportunity for computer training during the school day, as had earlier been discussed with the principal. Committee members were agreeable to this concept. Members of the committee with the least amount of computer experience were the most enthusiastic about this opportunity for further computer training.

The computer lab had 10 Apple IIe computers, 2 Apple IIgs computers, and 3 ImageWriter II printers. Most of the computers were equipped to access a printer. One Apple IIgs has been specially configured with two 5.25" and two 3.5" disk drives for copying disks. The IIgs was dedicated specifically for the use of the classroom teacher when she visited the lab.

The attendance schedule for the computer lab had been arranged by the principal when making up the school schedule in the fall. Classes were scheduled to be in the lab three days a week for twenty minutes each. Teachers would be required to attend the lab with their students. During this period each teacher would preview software to become familiar with its content and assess its suitability for her students. The teacher would also be able to use this time to learn how to copy disks, utilize software productivity tools, or observe students as they interacted with the computers. In this arrangement teachers would have the advantage of having access to the computer coordinator if they encountered problems with the computer or had questions regarding the software. Also, teachers would no longer be isolated from communication and feedback in making decisions concerning suitable computer activities for their students, or in learning to use a computer themselves.

To prevent students from interupting their teacher's computer time, they were informed that their teacher was in the lab to work independently from them on the computer. All questions during computer lab should be directed to the computer coordinator.

Problems in Implementation of School Day Inservice

As with most new programs, School Day Inservice encountered problems with implementation. Problems could be categorized as those which were linked to: (1) delivery of hardware; (2) scheduling of students into the lab; and (3) two special situations. We will discuss each of these categories of problems.

Due to the last minute notification of the grant approval, ordering of the hardware, software, and even the employment of the lab coordinator were delayed until school began. At the same time McCraw was hired, the equipment was ordered. McCraw was immediately tasked with selection and ordering of software. The delay of the delivery of hardware gave her time to develop the software catalog, as well as a proposed curriculum for the teachers and students who would be attending the lab classes. The principal borrowed an Apple IIe from one of the classrooms so that McCraw could compile an inventory and review each piece of software in the school. A database of software was developed using *Appleworks* so that future acquisitions could easily be added to the list. Although this time was used advantageously, it contributed to the delay of the inservice. About a month into the school year the computers arrived, minus all of the disk drives. By this time McCraw and the principal agreed that classes must begin. Classrooms were robbed to equip the newly arrived computers with enough disk drives to begin classes on October first.

The second category of problems was generated by the lab schedule. Mr. Quayle had developed the lab schedule with one consideration in mind: that each student in school would attend the lab three times per week. Taking into consideration the usual scheduling conflicts related to sports, music, and other special classes, computer classes were scheduled from 8:30 until10:50 and from 11:40 until 1:35, with classes attending every twenty minutes. A planning period was inserted from 1:35 until 2:35 and the last class of kindergartners arrived at 2:35 and stayed until 2:55. It immediately became apparent that there was no time for passing between periods. This meant that the class and teacher must be standing in the hall waiting for the previous class to finish in order to receive their entire twenty minute lab time. There was barely even time for application switching, which was necessary about 4 times per day.

Inservice was therefore taking place under the constraints of : (1) timely arrival of the class into the lab; (2) the lab coordinator having their software selected and ready to use; (3) the class quickly oriented as to their task for the day; and (4) the teacher oriented to her task for the day. With a smooth transition, about five minutes was lost to either the arriving or departing class. If a teacher was delayed or forgot about the lab (which often happened) as much as half the lab period would be used before everyone was on task.

For kindergarteners and even second graders a 10 minute session would suffice. However, the third through sixth grades needed all of their lab time because they were sharing a computer between two students as touch typing classes began. This gave each student no more than 10 minutes per class time to practice typing. It was soon apparent to the lab coordinator that this was not enough time.

The ability to provide School Day Inservice depended on the ability to free the teacher during the time that her class was in the lab, but beginning typists could not be sacrificed for that reason. Therefore the next experiment was to split the classes so that no more than 10 students would come every other period and have the entire 20 minutes to practice one lesson of the typing program. This was a better arrangement for the teaching of typing but again delayed the School Day Inservice. Now all students, minus their teacher, would attend the lab for two class periods one week and for one class period the following week.

An exception was made for one particularly effective simulation, MECC's *Oregon Trail*. For this program, each class was brought back to the lab along with the teacher. Sharing a computer was not detrimental to the success of this application. Students were encouraged to plan their strategies together and take turns using the keyboard. The inservice could continue when programs other than the typing lessons were used. Since typing practice was essential for the beginning typists, the curriculum was again revised so that two days of the week could be devoted to typing by the students and on the third day, the entire class would attend with their teacher and use software other than the typing program. Inservice would now be conducted once a week. Although far from ideal, the network for communication was still in place and the teachers were free to preview software, watch while the coordinator conducted the lab, and otherwise become more familiar with the computer.

A final scheduling problem occurred when several of the more sophisticated simulations required more than the twenty minute lab period. A last compromise was that the entire class would meet on alternating weeks for forty minutes one of the three days to do a simulation. The remaining two days would be used by the split classes to continue to improve their typing skills. That still gave biweekly contact with the teachers and provided beginning typists with structured practice in typing skills.

Two Special Situations

Two special situations were encountered in the school. The first problem dealt with a class that was larger than twenty students and presented an immediate inservice problem. Because the fourth grade had approximately 27 students, each half of the class was assigned its own twenty minute lab period. It was virtually impossible to arrange for School Day Inservice for this teacher. She would always need to remain in the classroom with the other half of her class.

The other situation developed with the two kindergarten classes. From the first day it was apparent to the lab coordinator that these little ones were very dependent on their classroom teacher. She was in constant control of their activities and needed to monitor their needs in the lab. A few months into the program, these students were more independent and could now work without her constant attention, which freed her for some inservice.

Assessment of the School Day Inservice

As the six classes in kindergarten through second grade continued to attend the lab with their teachers, assessment of the value of the School Day Inservice could begin. One computer with dual disk drives was dedicated to teacher use. This meant that the copy utility was available while the lab was in progress. Often the teachers would come in to find disks, labels, and sleeves awaiting them. The teachers were shown how to use the copy program, label the disks, and insert the next disk. Other practice sessions included booting up the copy program and troubleshooting hardware connections. The majority of days these teachers spent previewing and selecting software. One example of the success of this venture was the MECC program *Right of Way*. This is a program designed to teach small children right from left. The first grade teachers decided that one part of the program would work and another would need further discussion. They decided to use the simple part for one 20 minute session and then take the program back to the classroom and discuss the next phase before trying it out in the lab. This combination of lab and classroom instruction proved to be successful.

Conclusion

Coming from an instructional design background, the authors realize that the perfect system has a built-in plan for continual assessment and revision. The perfect lab situation has to be tailored to the training needs of each school. The majority of the teachers had very little computer exposure; therefore, the presence of the computer coordinator for reinforcement has been vital to their training. As the teachers gain more confidence and experience, the role of the coordinator will be revised from trainer to consultant. Each school will necessarily have to experiment in order to find solutions that fit its own needs as this school did. The School Day Inservice is working for us for the moment, but at any time changes can be enforced to fulfill immediate needs.

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A Media Education Program for Teachers of High-Risk Students

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Abstract

The perceived effectiveness of an innovative media education program for teachers of high-risk students was investigated. In addition, the use of media by teachers and students as well as the degree of effectiveness of thirteen selected types of media frequently used in the classroom were examined. Evaluation data were collected through the administration of a questionnaire that utilized forced choice and open ended questions. The results appeared to support the implementation of the media education course and the use of media by both teachers and high-risk students. Computers and videography were identified as the two most effective types of media used by this group of students.

Background

Recent research suggests that the use of media in the school's curriculum has had a favorable effect in enhancing learning and motivation with high-risk students (Peck & Catello, 1990; Bialo & Sivin, 1989; Friedman & Kephart, 1989; Small, 1989). The effectiveness of media, however, is largely dependent on an instructor's familiarity with the selection and use of the various types of media. This includes selecting the media that best matches both the school's curriculum and learner characteristics, knowing how to operate the equipment, and implementing mediated activities in the classroom in a manner that captures the interest of this specific group of students.

In an effort to reduce the dropout rate of students, a number of school systems in Georgia are currently seeking the assistance of higher education institutions to deliver workshops and/or media courses for teachers of high-risk students. Their requests have focused on updating teachers with the latest types of technology, familiarizing teachers with software that has proven to be effective with high-risk students, and introducing innovative activities that motivate and enhance student learning.

A review of the literature revealed a lack of research on the impact of media education programs or workshops delivered to interested school systems. Therefore, this study's findings may provide a framework for the development of future media courses to practitioners in the field who teach high-risk students and generate more awareness and interest in this type of collaborative, educational approach.

The primary purpose of this exploratory study was to design, implement, and evaluate the perceived effectiveness of an innovative media education program delivered to teachers of high-risk students in Georgia. Secondly, the study was conducted to assess the observed effectiveness of media in use by both teachers and students and to examine the degree of effectiveness of thirteen selected types of media frequently used in the classroom. The four research questions that guided the study were:

1. In teachers' opinion, how effective was the media course, MED 690, in enhancing teachers' knowledge and application skills in the use of media? 2. How effective was media perceived to be when used by teachers and high-risk students? 3. How effective were the thirteen selected types of media perceived to be in enhancing learning and motivation with high-risk students? and 4. What aspects of the media course appeared to be the most valuable in familiarizing teachers with media selection and use?

Method

Subjects

Twenty seven teachers of high-risk students in one Georgia county school system voluntarily enrolled in MED 690, Using Media to Enhance Student Learning and Motivation, offered in the winter quarter of 1991. They included administrators and teachers in grades K-12.

Course Development

After several planning sessions with the county's administrative staff and the instructional team at West Georgia College, a media course was designed to meet their expressed media needs. The course focused on introducing a variety of media and mediated activities that this group of teachers could readily integrate into their teaching practices.

The innovative media education course that evolved consisted of four major aspects: media production; teaching reading skills incorporating media; teaching students how to use and/or produce media; and evaluating media materials that could be used with high-risk students. After receiving introductory information in each of the above areas, the students were required to complete four class projects: 1. design and develop a variety of media for use in the classroom; 2. select a new and innovative media technique for use in teaching a reading activity, implement the technique, and make an oral presentation on the outcome; 3. select a medium that interests students, teach them how to use and/or produce the medium, and make an oral presentation on the impact of this experience; and 4. select, evaluate, and make an oral presentation on prepared materials that could be used with high-risk students or develop a bibliography of audiovisual materials and books that would be appropriate for high-risk students.

Procedures

At the end of the ten week college course, class participants completed an exploratory survey that collected both qualitative and quantitative data. Closed-ended questions, recorded on scantron cards, were used to collect demographic data on teacher characteristics. Forced choice questions, utilizing a five point Likert scale, were used to collect data on teachers' perceptions of the perceived degree of effectiveness of the media course, the use of media with teachers and students, and thirteen selected types of media. Respondents were asked to select a number from one to five that represented their observations of the degree of effectiveness of each of these variables. A five indicated the variable was perceived as very effective while a one indicated the variable had no apparent effect. In identifying the aspects of the course that were viewed as the most valuable learning experiences, open-ended questions were used.

Analysis

Frequency counts were tabulated for each demographic question then converted into percentages to provide an overview of the background of the teachers enrolled in class. The teacher's gender, age, teaching grade level, years of teaching, and years of teaching high-risk students were compiled.

In analyzing the perceived effectiveness of the media course, the use of media by teachers and students, and thirteen selected types of media, the completed scantron cards were analyzed by computer. The data were converted into mean scores and then rank ordered from the highest to the lowest mean scores.

A content analysis was conducted to identify the aspects of the course that were viewed as the most valuable. The open-ended questions were read several times by the investigator to capture the spirit of what the teachers were reporting. Individual responses for each question were then extracted, tabulated for their frequency of occurrence, and rank ordered from the highest to the lowest frequencies.

Results

Twenty six of the twenty seven respondents completed the survey (96.3%). The majority of the participants were women between the ages of 40 and 49. The largest groups of teachers were those who taught grades K-3, had one to five years teaching experience, and had taught high-risk students from one to five years. The complete demographic data are listed in Table 1.

The mean scores on the perceived degree of effectiveness of the media course and use of media by both teachers and students indicated that all three variables were perceived to be effective in enhancing the teaching and learning process with high-risk students. The mean

Table 1
Demographic Data on Teachers Enrolled in MED 690

		N	%
1.	Gender		
	Female	24	92.3
	Male	2	7.7
2.	Age		
	21-29 years	4	15.4
	30-39 years	5	19.2
	40-49 years	12	46.2
	50-59 years	3	11.5
	60 or more years	1	3.9
3.	Teaching Grade Level		
	K-3	11	42.3
	4-6	6	23.1
	7-9	3	11.5
	10-12	3	11.5
	an administrator	3	11.5
4.	Years of Teaching and/or Serving as an Administrator		
	1-5 years	8	30.1
	6-10 years	4	15.4
	11-15 years	4	15.4
	16-20 years	6	23.1
	21 or more years	4	15.4
5.	Years of Teaching High-Risk Students		
	1-5 years	11	42.3
	6-10 years	3	11.5
	11-15 years	4	15.4
	16 - 20 years	6	23.1
	21 or more years	2	7.7

Table 2
Perceived Course and Media Effectiveness

Variable	Mean
• Media Course	4.15
• Use of media by teachers of high-risk students	4.50
• Use of media by high-risk students	4.65

Table 3
Aspects of MED 690 Perceived as Most Valuable

Rank	Course Aspect	N	%
1.	Teacher presentations summarizing the use of new, innovative media with students to promote reading	18	69.2
2.	Teacher presentations summarizing the media, hands-on experiences with high-risk students	17	65.4
3.	Teacher designed and produced media	12	46.2
4.	Course content on the use of videography in the classroom	8	30.8
5.	Course content on the use and applications of various types of media	8	30.8
6.	Course content on the use of photography in the classroom	7	27.0
7.	Course content on emerging technologies	7	27.0
8.	Teacher generated bibliographies of audio-visual materials and/or books for use with high-risk students	7	27.0

Table 4
Types of Media Used by High-Risk Students

Rank	Type of Media	Mean
1	Computers	4.65
2	Videography	4.54
3	Learning Models	4.42
4	Multimedia Programs	4.35
5	Realia and Simple Media	4.31
6	Large Displays	4.19
7	Audio tapes	4.08
8	Puppets	4.04
9	Photography and Graphic Duplication	3.96
10	CD-ROM	3.73
11	16 mm Films, Filmstrips	3.58

scores ranged from 4.15 to 4.65 out of a possible score of five. Table 2 summarizes the results.

The content analysis that was conducted to identify aspects of the course perceived as most valuable yielded twenty different responses that ranged in frequency from one to eighteen responses per statement. Only those statements that had a frequency score of seven or more are reported in this paper. The rank ordered findings are shown in Table 3.

To determine perceptions of the degree of effectiveness of thirteen selected types of media, teachers were asked to recall their past observations of high-risk students using the listed forms of media and select a number on the Likert scale that represented their observations. The rank ordered findings are summarized in Table 4.

Discussion

This exploratory study, utilizing teachers of high-risk students in one Georgia county school system, found that a specially designed, innovative media education course was perceived by teachers as an effective means of enhancing teachers' knowledge and application skills in the use of media. In addition, the use of media by teachers and the students themselves was viewed by teachers as having a positive impact on high-risk student learning and motivation. Based on these preliminary findings, the investigator strongly recommends the development of additional collaborative media education programs or workshops between higher educational institutions and interested school systems. This educational alternative may be one of the keys to keeping our high-risk students interested in attending school longer.

The use of computers, videography, learning models, and multimedia programs were identified by this study as the four types of media most used by high-risk students. School administrators and teachers should review their present high-risk curriculum, examine the extent to which teachers and students use media, and consider instructional alternatives where media could be more fully integrated into the school's curriculum. This could include a variety of options: adding additional mediated activities to the school's high-risk curriculum; purchasing hardware and software (such as computers or video cameras) that interest high-risk students; and/or offering staff development opportunities focusing on the uses and applications of media in the classroom.

With the small sampling of teachers involved in the study, the investigator recommends the study be replicated using a larger population and in other states. Additional study would increase the reliability of these exploratory results. The present study may have been influenced by a number of uncontrollable factors such as the availability of media within this particular school system, the content that was emphasized in the media education course, teachers' familiarity with media hardware and software prior to taking the course, and the degree of teachers' exposure to and experience with some of the newer technologies such as CD-ROM and multimedia programs.

Credits

This study was made possible through a Special Initiatives grant from the Regional Center for Teacher Education at West Georgia College.

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Writing Skills and the Computer: A Graduate Course for Teachers

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Abstract

A two year special program combined a graduate course with on-site instruction and supervision in the use of computers in the writing process. During the first semester classroom/computer laboratory course, college faculty instructed the core group of twelve teachers of grades three through six in the basics of the writing process and the use of computers in the writing process. The second semester of the first year focused on the application of the knowledge and skills acquired by the core group in their classroom setting. The college faculty acted as resource master faculty by visiting the teachers and their pupils at their schools and advising them on their instruction.

During the second year of the program,core teachers utilized the principles of peer based instruction and support, instructed colleagues in the use of the computer in the teaching of writing, and collaborated with them in computer classrooms.

The Program

The primary purpose of this project was to provide instruction for a core group of teachers on using the computer in the writing process. The second purpose was to have elementary school pupils use a word processing software program to aid in drafting and revision.

The Participants

Twelve teachers were selected for the program. Selections were made as a result of interviews and teacher interest and experience. Of the twelve teachers, three were skilled in the use of the computer, five had some computer knowledge and four were novices. Their knowledge of the writing process was mixed, but only two were currently engaged with process writing in the classroom.

The Course Design

The one semester graduate course was designed around one on-going personal writing assignment to which half of the class time was devoted. The first half of the class was held in a seminar room and was based on readings, discussions and actual class activities of the participants. The second half of the class time was spent in the computer lab writing on the individual writing projects. At the same time that teachers were engaged in learning process writing at the computer, some were beginning to implement the same program in their classes. As a result, class discussions centered on difficulties encountered in the classroom and possible ways to resolve them. The teachers also began to bring their students' work to class and, through the use of the overhead projector, the participants were actually able to see the progress of the word processing instruction and the growth of the writing content. The second half of the first year included on-site visitations by the college teaching team during which demonstration lessons involving all stages of the writing process and computer instruction were conducted.

Introduction to *FrEdWriter*

One of the team members introduced *FrEdWriter* to the group. *FrEdWriter* was chosen for three reasons. First, it is public domain software and therefore we distributed as many copies as needed without being concerned about copyright violations. Second, it is a relatively uncomplicated program and students had little difficulty learning commands and how to use the menu. *FrEdWriter* documentation tends to be unclear; however, the instructor provided participants with a tabbing system that made the manual easier to use. The third deciding factor for the use of *FrEdWriter* was the fact that many area schools use Apple computers so it seemed to be a fine choice. Because the group consisted of both computer teachers and classroom teachers, those members of the group who were familiar with *FrEdWriter* brought charts and other handouts to class. We duplicated these so that students had visual aids to remind them of the commands they needed.

The instructor demonstrated the capabilities of a word processing program and then taught the *FrEdWriter* program. To model the behavior expected of the teachers, the lessons about computing were brief. A typical lesson on *FrEdWriter* commands lasted no more than fifteen minutes. During lab time, two members of the teaching team circulated to answer questions. The level of student expertise ranged from not knowing how to turn on an Apple computer to experience in using *FrEdWriter* in teaching children.

The Second Year

In the second year, the primary goal of the program was to strengthen skills in teaching the writing process through the use of the computer. This was achieved in two ways: on-site visits by the team of instructors continued and the requirement that each teacher was to recruit a second teacher to the program. Utilizing the principles of peer-based instruction and support, core teachers instructed colleagues in the use of the computer in the teaching of writing and collaborated with them in computer classrooms. By this stage of the program, several teachers had expanded their classroom writing across the curriculum. While autobiographical and fictional writing continued, report writing began to appear in two of the sixth grade classes. In addition, two third grade classes were writing biographies of other class members and several class newspapers were published.

Computer Considerations

The twelve environments varied. Some schools had labs with more than twenty computers while one school had a single computer in the classroom and five more that could be borrowed when needed. Schools with full-time computer teachers presented a problem since communication between the classroom and the computer teacher was limited.

Classroom observations revealed that direct teaching to the group had to occur in the classroom since student attention was quickly lost in the lab. Short mini-lessons provided any needed clarifications. The lesson on commands demonstrated how most commands began with the first letter of the command (e.g., l = load, s = save, p = print). When t = tutor was shown, a a student asked, "What if we forget t?" Another student suggested, "Then I'd say it's time to write it down." They did.

Saving entries proved a difficult concept since *FrEdWriter* does not prompt the saver, so students lost entries in the beginning. Centering was somewhat complicated and some of the teachers did not stress it. One of the team began to demonstrate the use of B and E commands for getting to the beginning and end of the screen. A third grader looked up and said, "You don't have to teach this aisle. You showed me last week and I showed the rest of them." The others had grasped that lesson with no trouble.

A command that the students enjoyed learning was the *move text* command. Unlike some programs, *FrEdWriter* uses a *Pacman*-like gobbling of the text to remove and replace text. The students loved to watch the text disappear and then reappear. However, they tended to keep their finger on the key much longer than necessary and the idea of a block move was lost. To counter this, the children were warned to take their fingers off the board periodically and reexamine what they wanted to move. For some, this seemed overwhelming and they preferred to retype a block rather than move it.

Program Evaluation

Several observations can be made about the program: fluency of writing improved through the use of word processing; the tedium of recopying handwritten drafts was eliminated through the use of the computer; a sense of real revision grew through the effectiveness of peer conferences and the ease of working with a clean printed copy. While adding and deleting was seen most frequently in the early stages of revision, gradual expansion and enrichment of text appeared. Students became comfortable, knowledgeable, and at ease with computers. Attention to mechanics became a natural outgrowth of the projected publication of a paper. Spontaneous mini lessons on parts of the writing process, mechanics of language, and computer operation provided students with valuable information when it was needed. Teachers were no longer evaluators of products but collaborators and coaches. The best way to look at what happened during the two years is to focus on one successful program.

A Third Grade

This class had never used the writing process. The teacher, a twenty year veteran, had no computer skills and was struggling to implement the writing process. There was strong parental support for the program in this class of twenty-three students. The teacher regularly sent home information about the children's progress and took pictures of the children at work and displayed them on a centrally located bulletin board.

The initial phases of the program were heavily teacher-directed as teacher and students struggled to find the right balance for their group. The teaching team paid frequent visits to the class, one conferencing regularly with groups and individuals, and the other offering instruction in using the computer and the word processing program. The teacher readily accepted guidance and a number of conferencing demonstrations led to increased empowerment of the students.

By the end of the first year, students were publishing a magazine and freely helping each other with drafting and revision. While proficiency in all stages of the program increased, text remained short and revision was difficult to sustain. Stories were similar and preselected topics were often used.

Twenty years of teaching traditional composition with assigned topics and teacher control of written work was difficult to erase. But this teacher wanted to succeed in the program and took suggestions and guidance willingly . By the end of the first year, the students were producing imaginative, self-directed text.

This class knew the keyboard and had little trouble locating keys. The question mark was problematic to some. A problem that was raised was that of the need to understand spacing. *FrEdWriter* does not use hyphens so that children who did not put spaces between words produced strange configurations on the screen. Since the teacher lacked experience, she panicked. This was an excellent introduction to punctuation since many of the students had free-floating periods and commas because of spacing. One of our mini-lessons centered on the need for spaces. This produced some discussion on the fact that computers only know what we tell them. Some third graders were surprised to find out that the computer wouldn't automatically capitalize or know to wrap around after certain words.

Related to this idea was the lesson on the *save* command, which pointed out the need to save new material and also to name the entry in an appropriate manner so that it would be easily remembered. The students saved their entries as story1, story2, story3, etc. We discussed why this was not the most efficient way.

Another file naming situation occurred when Matt identified entries with names like *birthdayparty*, but had difficulty typing the correct spelling the next time he tried to load the file. After a few tears, we convinced Matt that shorter names like party would suffice. Tamara could not understand why the computer didn't know that "storey" was the same as "story." I explained that if I called her name while looking at Tara, she would know who I really wanted to speak to, but that the computer doesn't know what we know without being told in the exact way we first entered the information. She was very excited about being smarter than the computer.

Implications for Computer Use

Although this was not an empirical study, some implications seemed significant. First, none of the results appeared stronger in classrooms with a larger number of computers. In fact, the classes with growth spurts in writing and in computing had fewer than eight computers. In these schools, students tended to share a computer or divide their time between drafting and editing.

Second, knowing the keyboard is necessary. The students who knew where to find the letters were at an advantage. Students who had used a keyboard mat before using a keyboard were more secure. Students who had used the computer for playing games only needed some time for developing word processing skills. Some teachers had instructed students on left and right hand keys. One teacher had painted red dots on right hand keys and green dots on left hand keys, but none of the teachers stressed typing skills. Whether children keyed with correct fingers seemed to make little difference. A difference appeared in children who had developed little or no fine motor skills.

Third, working in a computer lab with a class full of children can be overwhelming and threatening at first. The teacher cannot rely on traditional methods of control. Computers break, disks disappear, the power goes off, printers don't print, or they run out of paper. However, planning a backup assignment or giving students the freedom to move about to edit, revise, or confer with peers allows for a different way of teaching and actually frees the teacher for the important issues.

Credits and Acknowledgements

Grant for program provided by the Teleflex Foundation of the Teleflex Corporation, Limerick, PA.

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A Model for Software Preview and Selection

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Abstract

The models for software selection by classroom teachers typically include lengthy lists of selection criteria. Research has shown that teachers do not, in fact, select software by matching criteria and assigning points. This session will suggest a practical and usable software preview and selection process that meets the needs of teachers.

Background

Teachers who use or plan to use computers in their classrooms may be required to examine software with the goal of determining whether the software is of acceptable or high quality. In some cases, a single teacher may be examining software for use in her classroom. Alternately, a group of teachers may be meeting to make recommendations for a large-scale purchase or for a district license.

The systematic process of previewing software, matching the attributes of the software against a list of criteria, and making recommendations for its purchase has typically been called "evaluation" of software. A less formal process may be used when a small purchase is involved. Ellis and Kuerbis (1989) distinguish between the two processes by referring to the less formal process as "locating and selecting courseware" and using "evaluating courseware" to refer the the more formal process. Locating and selecting courseware is a personal activity that allows teachers to make judgments about software intended for classroom use by their students. The evaluation process they describe is a more formal enterprise that has the teacher using exhaustive lists of criteria from a published form such as the National Science Teachers Association (NSTA) instrument (1984).

Preservice and inservice teacher training seeks to familiarize teachers with a wide range of software applications within their teaching level or discipline. A systematic examination of software that requires a thorough preview of all of the program's components is desirable. The instructor or workshop leader may hand out a form with a long list of criteria, then ask participants to use the software and fill out the form, entering ratings on a preset scale for each of the criteria. Most forms include a provision for making a summary rating, either numerical or qualitative, and the form is filed or forgotten when the exercise ends. When the process is used for major purchase decisions, the results might be compiled and averaged.

The formal process described above is inadequate for beginning computer users for several reasons. First, the process does not allow for actual evaluation of a product. For example, a piece of software designed for developing fifth grade writing skills should be evaluated by using it with fifth graders over a period of time and followed up with an assessment of writing gains that are attributable to the use of that software. Second, the use of evaluation forms with preset criteria usually does not accurately reflect an individual teacher's priorities. For example, a teacher may reject a piece of software that requires a minimum of three hours of use because the logistics of continued use over a week would be highly disruptive. The teacher may rate the software low or very low on the criterion that addresses curricular fit, but the importance of that shortfall will be lost when averaged out with 9 other criteria on the form. The evaluation form system neglects the concerns of the teacher who says, "It's great software, but I would never use it." A third problem with the use of forms with lists of criteria is the immense amount of time needed to fill out the form. The time required to consider each aspect of the software, make a decision about the rating, and compile the final recommendation may well outweigh the time spent previewing the product.

Many teachers are familiar with the process of filling out software preview forms. Research (Carey, 1988) shows that this process is not how teachers actually select software. They select software that has been recommended by others or that they have had a chance to preview. Their selection choices are frequently based on cost considerations. For example, the teachers interviewed in the study revealed that they would begin their search by examining software that was already in the district's collection, particularly if the district held a distribution license. They felt that such software was "free." They also indicated that they would be more likely to select software that was available in class sets or lab packs over single copies of more expensive or appropriate software, regardless of its rating on other criteria. Almost all teachers in the sample agreed that they would reject software that did not adequately match their curricular outcomes.

An Alternate Model

The proposed model employs an open-ended process for software selection. Teachers select two or three titles from a collection of software. They choose the software by scanning titles, by following up on colleagues' recommendations, or by reading through the documentation. After thoroughly examining the software, either alone or in pairs, they are invited to rate the software as "Excellent," "Satisfactory," or "Inadequate." They enter the software title under the appropriate rating on a large chart or chalkboard that all partcipants can see.

The instructor or inservice leader then leads a discussion of the group's ratings. Individuals and groups are invited to explain why they have rated the software in a particular way. When a product is deemed excellent, the participant explains what features made that piece of software excellent *for him.* If a particular program is inadequate, the participant explains what feature caused him to reject the product. Participants and observers are often surprised to see that a product that is considered excellent by one teacher may be rated inadequate by another.

This systems allows teachers to rate a product without any preconceived notion of what makes a program excellent or inadequate. In fact, they may not have any conscious criteria by which they initially rate a product. The strategy employed by the software designer may "feel" negative to some teachers. For other participants, the same strategy may match perfectly with their teaching styles and approaches to the subject matter. When participants articulate the reasons for their ratings, they arrive at a dependable list of criteria that works for them and reflects their own style and list of priorities.

The model described above was designed by Dr. James Ellis of the Biological Sciences Curriculum Study (BSCS) in Colorado Springs. It has been in use for several years in workshops for beginning computer users in the areas of science and mathematics. One advantage of the model is that it requires minimal overhead in time spent deciding on the rating. A second advantage is that it provides a forum for discussion of the ratings, rather than filing and forgetting the recommendations. The model transfers easily to other settings, and teachers can employ the model in their own schools when trying to make software decisions. Finally, the model assumes no set of priorities or features that will make the software usable. A teacher who finds a number of flaws in a program but is eager to use the program in the classroom will be more likely to make provisions for working around the flaws. Conversely, a teacher who feels that a program is too complex or time consuming may reject the product even though the curricular fit is good and the design is acceptable.

The Model in a Preservice Setting

The proposed model has not yet been tested in our preservice classrooms. The preview process currently in place seeks to provide future teachers with some experience in software use and some knowledge of the range of features and software types they can expect to find in the school. These students lack the background and experience to judge the merits of the software, and their use of forms that list preselected criteria continues to be artificial and frustrating. The model described in this paper is being considered for adoption since the discussion component will address the problem of inexperience. Student discussion of the software features, guided by the instructor, will allow them to derive criteria and determine how high a priority they might wish to set. For example, in the traditional computer education preservice classroom, students agree that factual and typographical errors are unacceptable for classroom use. A discussion of this problem, however, might reveal that a good lesson could be built around having students discover the error while gaining the benefits of the software's intended use. Another program that was rejected by some students because they deemed it boring and tedious might give rise to a debate about what is boring and tedious for a third grader, compared to what is boring and tedious for an adult.

Using the Ratings

When the model is used by BSCS workshop leaders, the ratings are compiled by entering the information into a database. This allows each participant to return to her school with an extensive collection of ratings that can be searched easily and quickly when a software decision is needed. The compilation of the database also allows teachers to experience a practical application of database use as a teacher utility. The BSCS workshop leaders attempt to provide copies of the database for use with a variety of database management programs and various versions of software such as *AppleWorks.*

In the preservice classroom, the ratings might be used to generate lists of criteria for accepting or rejecting software. The opportunity to articulate criteria in words other than "fun" or "boring" is an advantage for instructors in the preservice classroom. Instructors also have an opportunity to model a process that is independent of their own values and priorities, and to explain how the selection process has implications for students' own educational philosophies and teaching styles.

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INTEGRATING TECHOLOGY INTO METHODS CLASES

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Margaret Niess in last year's Annual (1991) stated, "Preservice teachers must have an education that integrates teaching with computers and related technologies throughout the entire program." This year sees the addition to the Annual of an entire section on integration of technology into methods classes. Why is technology integration in teacher education so desirable?

- Appropriate use of technology enhances student learning of course content.
- By using technology in methods courses, we model behaviors we want our students to use in their teaching.
- Integration draws students' attention to the technology most relevant to the particular areas in which they will be teaching.
- Since many students take several methods courses, integration provides repeated contact with technology, increasing the likelihood that the students will incorporate technology into their professional repertoires.

Integration of technology into methods classes can be difficult and slow to accomplish. Equipment and facilities are lacking in many institutions. Many teacher educators have not taught with computers and other advanced technologies and so are not sure how to teach others to use them. Consequently, they need strong support from a specialist or an experienced user in order to feel comfortable. This support does not exist in most institutions. Finally, changes that take time and energy may not be encouraged or rewarded in institutions of higher education.

In spite of these somewhat bleak realities, significant progress toward integration has been made. The papers in this section describe a variety of such efforts, some involving program-wide initiatives, others involving efforts undertaken by individuals and small groups of faculty members to integrate technology into specific courses, and one reminding us of an almost untapped resource available for inclusion in methods courses.

Cathy Gunn at Northern Arizona University offers a model to other institutions struggling with ways to persuade education faculty to integrate technology into their methods classes. The key to success may lie in having a knowledgeable faculty member helping other faculty in their early technology efforts by teaching with them, providing support at the time when it is most needed.

George Fero outlines a four-phase project at Northwest Missouri State University to help teacher education faculty members to use technology to develop instructional units for their methods classes. Interested faculty members will develop units that make use of technology and then, in a novel "each one teach one" approach, will teach another faculty member what they have learned.

In pairing instructional technology with early childhood curriculum, Elizabeth Downs at Georgia Southern University describes a setting where newly learned skills in technology can immediately be put to use in the completion of assignments and the development of curriculum materials. Mary Jane Ford and her associates at the University of Southwestern Louisiana are in the process of developing and evaluating model lessons in science and social studies that use interactive media. Preservice students study the lessons and evaluate them in light of their own classroom experiences and what they know about effective instruction.

On the secondary methods front, Flora de Hart at St. Edward's University reports on a project to integrate technology into a curriculum course using self-paced modules. While still in its beginning stages, this approach represents a way of teaching technology hand-in-hand with methodology and curriculum. Janice Woodrow at the University of British Columbia reports on an exciting three-year effort to fully integrate technology into a physics methods course. Computer technology is used to supplement instructor presentations, to enhance learning in the classroom and in laboratories, and to serve the student as a professional tool.

As a reminder that methods instruction is not only for preservice teachers, Rachel Heller and her colleagues describe a program for inservice teachers at George Washington University to improve middle school science teaching by using a team approach, computer-aided hypermedia technology, and reflective practice. Beginning with a four-week intensive summer workshop, teams composed of a science coordinator, master teacher, and novice teacher work to learn about ways to use technology and then are provided continuing support in their efforts.

Finally, when integrating technology into their classes, teacher educators should be aware of resources we are not yet fully utilizing. Tronie Gunn at the University of Houston challenges us to make use of databases. She reviews the literature on educational uses of databases and suggests many practical ways they could be used as learning tools in university classes.

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Planning a Technology-Supported Teacher Education Program: Part II

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Abstract

The Center for Excellence in Education (CEE) at Northern Arizona identified technology as a Center-wide initiative in 1990 and 1991. Evidence of this initiative is seen in Center funding, faculty growth plans, and course syllabi. Technology integration involves educating faculty as well as students, and strategies used at CEE are shared. Elements and strategies that support this teacher education technology model include (a) identifying technology as a priority, (b) starting with faculty technology first (c) integrating technology into existing courses, and (d) providing faculty with a facilitator. This paper presents the progress CEE has made as a technology-supported teacher education program during its first two years and describes a model for technology integration.

The school restructuring movement has found a forum in educational journals and conferences since the publication of President Bush's *America 2000* goals. Restructuring with technology has also found its place in educational publications (Braun, 1990; Madian, 1990; Norris, 1991). Arizona has two support groups working towards a goal of restructured schools in its state: the Arizona State Legislature and the Danforth Foundation. Both groups are presently funding restructuring efforts in approximately forty Arizona schools. Sixty participants met at Northern Arizona University in a restructuring conference in early November, 1991, to share their schools' restructuring plans. Technology's role in restructuring was one of the topics and a message to teacher training institutions was clear: "Prepare our teachers for environments which are not a part of their previous knowledge base. Schools look different, feel different, and *are* different. We want teachers who are risk-takers, and who know how to use the technology that may be available to them in the future schools of Arizona." This message certainly has implications for teacher education programs in America. Northern Arizona University—and more specifically, the teacher education program at the Center for Excellence in Education—is scrambling to meet these needs.

The Center for Excellence in Education (CEE) at Northern Arizona University prepares over 400 teachers each year. Technology instruction is a Center-wide priority at CEE, as faculty and administration work toward integrating technology into existing courses in the teacher education program. Technology integration as an initiative is in its second year and involves educating faculty as well as students. This paper presents the progress CEE has made as a technology-supported teacher education program during its first two years, as well as future plans for continuing the initiative.

In 1989, the faculty of CEE clearly stated their priorities. A new faculty line was created that included half-time teaching in Educational Computing and Technology and half-time staff development. Faculty voted to integrate technology rather than add courses and they wanted someone to help them achieve that goal. In 1991, 90% of all faculty had computers in their offices, and a growing number of faculty were asking for help in including technology in their courses. Unfortunately, funds earmarked for technology were not yet available and members of faculty were working without adequate equipment. The remainder of this paper reports on the second year of technology integration at the Center for Excellence in Education.

Coordinator of Instructional Technology

Strudler (1991) writes that the goal of computer integration into teacher education programs is worth pursuing, but will be extremely difficult to implement without faculty change agents. The existence of a new Educational Computing and Technology faculty/staff development position was reported on at the 1991 Technology and Teacher Education Conference. This professor was named "Coordinator of Instructional Technology," a term synonymous with "Chair" in other institutions, which means that the Coordinator serves as a technology advocate on the leadership team.

The Coordinator of Instructional Technology is charged to pursue a campus-wide technology development center for faculty through a focus group that consists of faculty from other colleges at NAU with interests in technology. This charge includes gathering information and forming alliances for cooperative planning, grant writing, and sharing of expertise and equipment. We are in the process of pooling our resources (financial and human) as we look into a faculty development resource center—a place for faculty to become familiar with state-of-the-art equipment, to bring classes for demonstration, to develop technology lessons, or to teach using the technology. Faculty from six different colleges are working to compile a master list of technology found on our campus and an inventory of human resources—who are the experts in different areas of technology that are willing to share their expertise? A campus-wide faculty center for technology has the support of the Director of the Center for Excellence in Education, the Academic Vice President, and the President of Northern Arizona University.

Technology for Faculty First

A two-day faculty-organized technology retreat was held before Fall 1991 semester classes began. Included in the breakout sessions were hands-on workshops using *Aldus Persuasion* for instructor presentations, demonstration sessions of projection and presentation devices, multi-media demonstrations, and information sessions on BITNET, distance education, and technology research. Technology as a Center-wide initiative was introduced for the second year in a row, and faculty feedback was overwhelmingly positive.

One of the first steps in this technology initiative was to provide technology to faculty first. Inservice programs that place the teacher in an active role, emphasize demonstration, supervised trials and feedback, and other programs in which teachers share and provide mutual assistance to each other are more likely to accomplish their objectives than those that place the teacher in a receptive role without opportunities for practice (Moursund, 1989). Moursund also states that if we place the goals of inservice within the larger framework of the school environment and provide a collegial support structure, chances of institutionalizing any changes are improved (p. 5). Staff development is a major tool for implementing educational change, and CEE faculty and the leadership team recognized this by initially directing resources to faculty technology first.

All CEE faculty who want computers in their office now have them. Six faculty members use MS-DOS machines, twelve have Macintosh Plus computers, and the remaining fifty have Macintosh SE computers. All faculty have access to one of six laser printers, software applications on server, MS-Mail, BITNET, and the CARL system. By the beginning of the 1992 school year, it is projected that all Apple users will have a Macintosh SE or Classic. MS-DOS users are obviously in the minority in our institution, and software support must come from their areas or from grants, but CEE is committed to upgrading this hardware as money becomes available. The Technology Committee received approval of recommendations for a Faculty Technology Standard:

Center for Excellence in Education Faculty Technology Standard

Phase I

Macintosh Standard

- Macintosh Classic (or equivalent) w/40 MB Hard Drive, 2 MB RAM, and access to Server, *MSMail*, laser printers, *CARL*, & Bitnet

MS-DOS Standard

- 386 SX Bundle (Hardware is sold with a software bundle included through state buy)
- 40 MB Hard Drive
- 4 MB Ram
- 3 1/2" drive
- Mouse
- Color Monitor
- 5.0 Dos
- Windows
- Access to MSMail, laser printers, CARL, & BITNET

Phase II

Macintosh Standard

- Macintosh LC or equivalent
- Color Monitor
- 40 MB. Hard Drive
- 4 MB Ram
- Same access privileges

Integration of Technology into Courses

Faculty at the CEE were encouraged to include one personal technology component in their 1991 fall growth plans and one instructional or student component in their syllabi. Several faculty members made great strides in requiring students to use technology within a course. In one case, a special education professor required that a major paper be done using a word processor. A competency check-off system was used to determine student expertise, and workshops were conducted for those students new to word processing. This project was admirable, since it was an interactive television class with half of the class attending at a remote site in Yuma, Arizona (southern-most part of the state), hundreds of miles from the on-site classroom in Flagstaff (Northern Arizona). Personnel from the Yuma site agreed to monitor the check-off procedure and arrangements were made for word processing instruction.

A team of two Educational Foundation professors are piloting a technology component in two sections of an introductory education course. The course will be team-taught in a four-hour block with a one-hour technology requirement being added to the normal three-hour course. Both traditional and new media will be included. Students will go through a check-off procedure for word processing competency or will attend a required word processing workshop as part of the technology component. The workshop will be taught during the first semester by the Instructional Technology Coordinator and staff, with both EDF 200 instructors in attendance. In subsequent semesters Educational Foundations professors will teach the word processing component with support from the Technology Coordinator.

Other faculty are finding software applications that support their content and are adding a technology component to their syllabi. A reading professor has included an assignment in which students preview reading software and write annotations. Our current software library of three hundred packages does not contain the newest and best reading software, so phone calls and letters by the Coordinator of Instructional Technology brought in preview software for the semester. Secondary methods classes use two class sessions to see demonstrations of different software and to learn how to evaluate software. There is a shortage of secondary content software in the computer lab library, so again, preview software and cross-campus departments have provided a selection of software for student use. A math methods class spent four class periods learning Logo to support a problem-solving unit. A secondary reading class viewed an IBM videotape on "Ulysses" and discussed multimedia and its implications on text and reading. While software integration is not supported by every faculty member current activity represents all areas of instruction at CEE.

The Instructional Technology Coordinator also provides direct classroom support. The faculty instructor and the Coordinator work together so the instructor takes over some or all of the technology instruction in the second semester. All equipment is delivered to the classroom and set up ahead of class. At this point, the Coordinator acts as a consultant and the faculty instructor is supported but still teaches the technology component. An example of this teamwork is a reading practicum course in which a planning session identified five one-hour sessions of technology instruction or demonstration that would support the reading content. The Instructional Technology Coordinator took responsibility for four sessions, with the reading instructor taking the final session. The plan for the second semester is to transfer more responsibility to the reading instructor, with the Technology Coordinator providing the technical support.

Planning committees in the Departments of Instructional Leadership, Educational Leadership, Educational Specialties, and Educational Psychology are working to establish student exit competencies in technology, topics and assignments to instruct and help students meet those competencies, and planning of area-wide goals to cover but not duplicate technology instruction. CEE is committed to providing adequate technology instruction to preservice teachers without requiring a new course.

The Computer Lab—A Teaching Lab

The impact of our technology initiative was felt in the computer lab during the first semester of our second year. The lab was developed as a teaching lab, but in past years, students were able to use the lab for their own word processing needs, without cost. Because the lab was seldom reserved for teaching other than for two sections of a Computers in Education course, students considered the lab theirs. This past fall, the computer lab was closed for class instruction a total of ninety-two hours during the first eight weeks of class. Students were naturally upset that their personal word processing lab was closed to them more than it was open. A second indication of lab use can be noted in a usage report for the month of October. A total of 956 students signed in to use the lab during the month of October, with 1,002 users reported in November. While we have no figures from past years for comparison, this number of students using the lab for word processing or software preview indicate that the lab *is* being used.

The teaching computer lab at the Center has been renovated to enhance teaching. The lab now is arranged in a U-shape to allow a front teaching station that gives the instructor a view of all monitors and students the space to break into small discussion groups. Money was appropriated for proper wiring, a breaker box where all equipment can be turned on or off at one time (and with room for future add-ons), and for replacing temporary floor wiring outlets to wall outlets.

Technology was given priority in capital expenditures. The teaching lab has been upgraded from Apple IIe's and Macintosh SE's to Macintosh LC's with Apple II cards and drives. The students can use the Macintosh platform for their own work and the Apple II platform for software preview. The computer lab has an extensive library of Apple II educational programs that can be used for preview and class projects. Software "wish lists" from faculty were used to add the first new teaching software in a number of years, both in Apple II and Macintosh formats.

Instructional Technology

Computers in Education, an elective course, has been restructured to double the number of students able to enroll each semester. This was done by going to a lecture/lab configuration. Using the lab for all instruction limited the course to the number of computers—twenty. Now forty students attend a lecture section in a traditional classroom once a week. During this session, technology issues are discussed and software demonstration is possible with moveable teaching stations. The Macintosh station consists of a computer cart, a Macintosh SE, Mac Speakers, a PC Viewer, and a low-heat overhead projector. We still use an Apple IIe on a cart connected to a large monitor, but a Macintosh LC will soon make demonstrating both Macintosh and Apple II software easier.

The second class period of the week is a lab. Lab sections have been added to accommodate the doubled number of students in the two lecture sections, and a twenty-hour per week graduate assistant line was added to the computer lab for instructional support.

Funding Sources

Technology as an initiative has made capital funds available for purchasing Macintosh LC's in the computer lab and computers for faculty. Naturally, there are many other purchases that would add to our technology instruction: laser disc and CD-ROM players and discs, a scanner, color projection devises, mobile teaching stations, etc. The Technology Committee has recommended that the monies obtained from sale of Macintosh Pluses (as faculty are upgraded to Macintosh SE's and equivalent) go toward purchase of hardware requested by the faculty. Another recommendation of this committee is the purchase of a higher-end Macintosh for faculty use on a rotating basis. The Technology Committee will call for faculty proposals for such items as computers with more graphics capabilities, to develop materials, etc. The proposal must include a justification for the use of the new hardware and and a statement of how its use by the faculty member would benefit the Center. Plans include a rotation schedule over several years divided into months or semesters, with a lottery utilized for order of use. This schedule would enable all proposals to be funded.

The Technology Committee is also looking at collaborative grant writing and is presently in the process of putting together a hardware grant proposal to the University's Academic Computing Steering Committee.

Summary

The progress we are making at the Center for Excellence in Education goes beyond individual instructors beginning to use technology for themselves or with their classes. There is a wonderful attitude that is positive and upbeat. Not all professors have bought into the technology initiative, but the success stories are numerous and rewarding. This positive attitude is one CEE wants to share with other teacher educators. Elements and strategies that support this teacher education technology model include (a) identifying technology as a priority, (b) starting with faculty technology first, (c) integrating technology into existing courses, and (d) providing faculty with a facilitator. The Center for Excellence in Education does not claim this model as the best model, and we still need encouragement, suggestions, and sharing with other educators who have gone beyond this introductory stage.

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The Development of Instructional Units in Technology for Teacher Education

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Abstract

This article is a progress report on a project being conducted at Northwest Missouri State University to develop instructional units in the use of technology in education for teaching methods courses in education and content fields. The project is based upon ethnographic methods and involves four phases. Phase I consists of an in-depth search of the literature on the uses of technology in education. Over 50 articles and documents were reviewed that discussed the uses of technology and how other institutions have implemented technology instruction into teacher education curricula. Phase II involves a determination of technology available on campus. Phase III consists of a survey of teacher education faculty to determine existing uses of technology in teaching and whether faculty would be interested in developing units for methods courses. These three phases have been completed. Phase IV of the project, which will be implemented during the 1992 Spring semester, involves the inservice training of faculty in the use of technology in the classroom and the development of instructional units in the use of technology in education for use in teaching methods courses.

The use of technology in society is quickly growing beyond the realm of luxury. Very few schools and classrooms in this country have no access to various technologies ranging from VCR's to computers and satellite communications. Teachers who have attempted to use these technologies have often had to rely on trial and error, sharing through conference minisessions or short inservice programs. The technology available in an elementary classroom may often exceed the resources available in a university classroom used for teacher education courses. Additionally, the university instructor's knowledge about the use of technology in general may be less than that of the students in the classroom.

Northwest Missouri State University is an electronic campus. Every faculty office and dormitory room is equipped with a terminal and printer and direct access to over 200 applications on the university's mainframe computer. In addition, there are eight computer laboratories on campus using microcomputers, on-demand laser disk transmissions to dormitory rooms, television and radio studios, and access to remote services via Internet. With the exception of direct applications in business, computer science, and science courses, most of these resources have been used primarily for word processing, e-mail, and scheduling. The few teacher education courses that have units on the use of technology in classroom teaching generally have descriptive units rather than interactive demonstration or "hands-on" units.

The purpose of this four-phase study is to develop units of instruction that can be used in methods courses in the teacher education program. Phase I involved a search of the literature to summarize the technology-based educational practices in school classrooms. Phase II involved a determination of the facilities, hardware and expertise available on the campus at Northwest. Phase III involved a survey of teacher education faculty to determine what technology was being used by the instructors and what technology was being taught in educational methods courses. At the time of this writing, Phases I, II and III have been completed. Phase IV involves working with selected interested faculty to develop a unit of instruction for each of their courses that uses technology already available on the campus.

Phase I

The literature search on the topic of technology in education yielded over 50 articles or documents. One resource proved to be of significant value in providing initial sources, namely the *Technology and Teacher Education Annual 1991*. For the purposes of this article, a few citations from this source will be used to establish the basis for the project.

Niess (1991) listed competencies that teachers at each level should have attained through the teacher education program, suggesting that every teacher should have the skills to use a computer as a personal tool and to integrate the computer into teaching in a variety of ways.

Dershimer and Dershimer (1991) believed that teachers were more likely to use the computer in the classroom if they had suitable opportunities and support. They developed a model to involve college faculty who were inexperienced in computer usage, did not use the computer in their instruction, and had no background in the selection of software. They found that it took little time to get colleagues to acquire minimal expertise provided friendly software was utilized.

Bauer and Grzenda (1991) discussed the redesign of a course in technology use for teacher education students at the University of Northern Colorado. Through a survey, the authors found that students who took the course generally felt well prepared to integrate some media into the curriculum.

Other cited uses of technology in education include applications in writing, math and science, and computer-assisted instruction. Specific hardware being used includes computers, videodisc players, and telecommunications hardware. While many software applications are cited, a clearly growing trend is the application of *HyperCard* and hypertext units into the curriculum.

Phase II

The purpose of this phase of the project was to determine the technology available on campus and its accessibility to teacher education faculty and students. Once these goals were accomplished, a strategy to enable the technology use by faculty and students could be developed.

Through my involvement as a member of the university Academic Computing Committee I was aware of most of the technology resources available on campus. They included a Digital VAX system accessed through terminals in dormitory rooms, faculty offices, and three computer labs. These were used primarily for word processing, class scheduling, and electronic mail. Five computer labs used IBM-compatible PCs, three were Macintosh labs, and an Apple lab was used by elementary education students and pre-K to sixth grade students in the Horace Mann Laboratory School in the College of Education. A variety of IBM-compatible and Macintosh computers, CD-ROM and videodisc units, and VGA projection systems purchased by specific departments or individual faculty members were generally not available for use by members of the university community outside the departments that owned them.

A videodisc system was available for use through the VAX. It included the capability for computing services personnel to create videodiscs locally. Students could request instructional videos through the VAX and view them through a TV monitor in each dormitory room via a local cable network. In addition, the university TV and radio stations had complete recording, production, and broadcast services available to the university community.

One problem that was immediately identified was to determine how access to the necessary equipment could be gained in those departments in which teacher education programs were not available or where specific equipment was controlled by individual faculty members not involved in teacher education. The first step would be to involve those faculty who already had access to the necessary technology.

Phase III

While technology was available on the campus, no one knew the extent of its use in teacher education courses. Therefore, a survey was developed and distributed to 45 faculty members involved in teacher education, including all members of the Departments of Curriculum and Instruction and Educational Administration. Other faculty members surveyed included those responsible for teaching subject area methods courses in other university departments.

The survey asked respondents to describe their use of technology individually and in instruction; to list specific technologies used, if any; and to state whether they would be willing to participate in local inservice programs in the use of technology in instruction.

There was a 75.6% return of the surveys. Of the respondents, 87.9% indicated that they used technology themselves and 64.5% cited use of technology in methods courses. When asked which technology was being used, 79.4% of the respondents cited the use of the university VAX in personal use and teaching and 94.1% cited use of a VCR. When asked to indicate computer applications used by themselves and their students, 84.3% cited word processing, 39.2% cited CAI programs, and 14.7% cited interactive video. If inservice programs on the development of technology-based instructional units were available, 84.4% of the respondents would participate.

The results of the survey have several interesting implications. First, a commonly accepted belief across campus is that a large number of faculty refuse to use the computer system for anything but minimal applications such as advisement and scheduling. The results of the survey appear to contradict this supposition. Second, Missouri requires a competency in the use of computers for students seeking teacher certification. This competency has been assigned to far fewer courses than the number in which technology is actually being taught. Finally, the literature indicates that one of the most difficult obstacles to the implementation of teacher education units is gaining interest among faculty members. The results of this survey indicate that teacher education faculty members want to learn how to use and teach technology, so that finding faculty members to implement Phase IV of this project should not be as difficult as was originally anticipated.

Phase IV

The final phase of this year-long project will be implemented during the Spring 1992 semester. Using an instructional model being developed by a high school in the Northwest region to train its faculty in the use of technology in instruction, selected faculty members in appropriately equipped departments will be trained. Each faculty member involved in the pilot group will follow the same general instructional plan, but will customize the instructional unit to fit the particular methods class being addressed. We expect that between five and ten faculty members will be involved.

The faculty members who choose to participate in the inservice training and unit development will be asked to select one appropriate unit or lesson that will be taught during the second block of classes. They will then use skills learned in the training as well as equipment and support from computing services to develop the lesson or unit. Each person will maintain a journal listing the processes and procedures used in developing the unit, as well as successes and failures. Once the unit is developed, the instructor will use it in teaching.

Following the development of the first instructional unit, the participants will be debriefed as a group and asked to assist in training a second group of faculty participants in the use of the technology. After training and assisting the second group in developing an instructional unit, the initial participants will be asked to develop an instructional unit specifically in the use of technology in education for the appropriate methods course. This process will be followed until a technology-based instructional unit on the use of technology in education is developed for each area of teacher certification and for the general methods courses. Throughout the training and development process, evaluative data will be gathered using short questionnaires, focus interviews, and direct observation.

Reporting the Results

The results of Phase IV of the project will be reported as the project progresses. A final report that will include complete descriptions of the instructional units will be compiled during the Summer of 1992 and should be available thereafter.

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Integrating Technology into Teacher Education

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Abstract

Current education reform movements cite a need to include technology as a core of instruction. To meet this need, future teachers must have the skills required to integrate technology into learning environments. The Early Childhood Education program and the Educational Technology program at Georgia Southern University have joined forces to create a course called "Introduction to Instructional Technology" that has as its goal the provision of these skills. This paper presents the activities in the course and describes how the skills are applied in a required core curriculum class.

The current educational reform movement has focused on changes that should occur if our schools are to meet the needs of students as we move into the 21st century. Many of the reform models suggest that changes in our schools should include incorporating more technology into the classroom.

If our teacher education programs are going to meet the expectations of the reform movement, we need to prepare teachers for a technologically advanced environment. Additionally, if we expect to see successful change in our educational system, teacher training must incorporate experiences that will provide future teachers with the confidence to utilize technology in their classrooms. The faculty in Early Childhood Education and the faculty in the Educational Technology program at Georgia Southern University have worked together to create a technology course as part of the core requirements for Early Childhood Education majors. The design of the technology course was guided by three principles: (1) the activities in the course would be linked with the activities in other program courses; (2) the computer would be incorporated throughout the course as a tool for production, selection and utilization; (3) the course activities would integrate the media resources of the University and the laboratory school.

The students take the technology course in conjunction with the required core curriculum course. The technology course includes basic production techniques, basic equipment operation, video camera operation, word processing, data base management, the computer as a production tool, and media selection strategies. The students learn these skills in the technology class and practice the skills in a lab setting. They are then expected to complete projects that demonstrate their competency in these skill areas and subsequently to use these newly acquired skills to complete projects in their core curriculum course. This continuous reinforcement provides students with distributed practice so that they are more likely to master the skills and remember the procedures involved. The course also gives them an opportunity to see a variety of technology applications and helps them conceptualize teaching strategies that incorporate the applications.

The structure of the course is continually changing. At the end of each quarter, the faculties from Early Childhood and Educational Technology convene to formulate changes and improvements in the course.

Competency 1 - Introduction to the Computer

Students begin by discussing various types of computer literacy. This discussion is followed by a visual presentation and discussion of the history of computers. The visuals for the history discussion are presented using Hypercard so that students will have an opportunity to see an application of the computer as a teaching medium.

Students are next introduced to hardware and software concepts. Various hardware components are described, and the students are shown proper procedures for handling and using software.

The students have their first experience on a computer through the use of *Apple Presents Apple*, which talks each student through the booting up phase of using the computer and provides an excellent tutorial to help familiarize students with the Apple IIe computer and various keyboard functions. After students have completed this tutorial they proceed through *Inside Apple*, which provides basic information about the internal functions of the computer. At the completion of these activities, students are expected to be able to boot up the computer and use the various special keys to progress through a commercial program.

Competency 2 - Instructional Uses of the Computer

Various computer assisted instruction (CAI) applications are described to the students and demonstrated using a projection panel attached to an Apple IIe computer. The students follow up this demonstration in their methods courses by reviewing programs in specific content areas and evaluating them for specific uses.

Competency 3—The Computer as a Tool of Instruction

A discussion and demonstration of the computer as a tool of instruction is presented to the students. Word processing is demonstrated (again using the overhead projection panel and the Apple IIe) through the use of *FrEdWriter*. Because *FrEdWriter* is public domain software, we have created a lab pack of 20 copies of this program and students are free to make their own copies. After the students view a demonstration in class, they proceed to the computer lab for a practice activity in which they are given written directions to guide them through the correction of an existing document on their lab disks. This activity helps to familiarize them with the various editing functions common to word processors.

Upon completion of the practice activity, the students complete a *FrEdWriter* assignment that involves composing and writing a letter to parents. The letter may address a child's progress, an open house, or a field trip, for example. The assignment includes demonstrating ability to left-justify, center, or right-justify text. Students then use their newly-acquired word processing skills to write papers in their other classes.

In addition to word processing, students are introduced to the application of database management. For this activity, we use *FrEdBase*, another public domain program, so that again we are able to produce a lab pack of disks for student use. The program and functions are demonstrated in class through the use of the projection panel, and the students then proceed to the computer lab to become familiar with database management. They first complete a practice activity in which they use a guide book of written instructions to manipulate data already present on a data disk, and then they create their own database of a class of students. The record for each of the students in their class must contain six fields. When they have completed the database, they print out a hard copy of the records they have created.

The students practice this competency by creating a database of the materials and activities that they are producing in their classes, using any fields they consider appropriate. Generally, these fields include grade level, content, subject area, and type of material. This activity replaces the generation of card files that students were asked to produce in the past.

Competency 4 - Using the Computer as a Production Tool

One of the goals in the Introduction to Instructional Technology course is to provide future teachers with the skills needed to produce instructional materials. They are initially taught basic design and selection strategies, after which the computer is introduced as a production tool to assist in applying those strategies.

The students first create an activity for use in a learning center, using the Minnesota Educational Computer Consortium (MECC) software. Using *Puzzles and Posters* or *Crossword Magic*, students create an instructional game based on a given group of learners and an instructional objective. Once complete, the activity is printed out, mounted, and laminated with the answers on the back so that it can be used in a learning center.

Students then create an instructional handout incorporating graphics and large text for headings, using *Print Shop* and *FrEdWriter* . Again, they must identify a grade level and an instructional objective before producing their handout. Students learn how to use the letterhead selection to create the handout heading and then insert the paper in the printer to add the text created using *FrEdWriter*. Subsequently, they use *Print Shop* to create subtitles for bulletin board displays and either *Print Shop* or *The Children's Publishing and Writing Center* to create graphics and lettering for overhead transparencies. The activities that the students create can be included in their notebook of activities for the curriculum course.

Competency 5 - Emerging Technologies

Future teachers must be aware of existing technologies so that they can effect change within the schools. To acquaint students with emerging technologies, we begin by showing them various types of videodiscs and then demonstrate interactive video, using videodiscs hooked up to an Apple IIe computer. The students are next familiarized with CD-ROM through a lecture and demonstration, after which they complete a CD-ROM activity at the lab school media center. The activity is coordinated with the design of the instructional handout described in Competency #4. The students identify a grade level and an appropriate instructional objective, and then use the CD-ROM to complete a search for information related to their objective. This information is then used to create the instructional handout.

Students are next shown how to use an automated media center to search for commercially produced non-print materials to support an instructional objective. After being taught how to operate the on-line system, they search for non-print materials related to their subject area and preview the materials to select one that matches their objective.

Competency 6 - Equipment Operation

In addition to familiarizing students with emerging technologies, the Introduction to Instructional Technology course is designed to assist students in utilizing basic equipment in the classroom. The students observe demonstrations of such devices as slide projectors, sound/slide projectors, filmstrip projectors, sound/filmstrip projectors, opaque projectors, audio cassette tape recorders, and overhead projectors, and then practice using these devices in an equipment lab. When the students feel they have mastered the various pieces of equipment, they complete an equipment operation test.

The Early Childhood Department has identified a need for the students in their program to be able to operate video equipment. In addition to the equipment operation exercises identified above, students must also demonstrate competency in setting up a video camera (using a tripod and setting the white balance), performing basic video camera movements (panning and tilting), and using different video camera lens functions (focusing and zooming). Students demonstrate these skills by videotaping the instructor moving around the classroom and then set up a VCR and play back the tape. The students will be expected to videotape each other in future classes as they are teamed with a partner for their student teaching experience.

In conclusion, if we are to look to future teachers as change agents in the implementation of technologies into the schools, we must verify that they are prepared with the skills necessary to bring about these changes. In addition, the students need the opportunity to evaluate different innovations that can be used with current and emerging technologies.

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Using Interactive Media in Elementary Social Studies and Science Classes

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Abstract

Multimedia-based lesson plans have been developed for middle-school social studies and science classes. The social studies lesson utilizes 35-mm slides and interactive videodiscs in conjunction with the text, and the science lesson utilizes a *HyperCard* stack to support the implementation of a discovery-based concept attainment teaching strategy. The paper describes both lesson plans and reports on an evaluation of the social studies lesson by preservice teachers.

The kindergarten class of 1991 will graduate from high school in 2004 and will "live in a world characterized by a staggering volume of information, varying sets of values, and a growing interdependence among nations" (NCSS Task Force, 1989, p. 15). Our task as educators is to facilitate the life-long learning necessary for full participation in this global community. The necessary knowledge, understanding and skills must be developed at an appropriate level during each year of a child's schooling.

Simply presenting the requisite material is not enough, however; the manner of presentation must be compatible with the interests and abilities of the students and must provide the motivation, interest, and background information needed to make the learning meaningful. Today's middle school students have grown up in a period of time when entertainment and games are most often provided by television or a teleview toy and they often view reading as a chore or bore which must be endured in school. Instructional technology has long been viewed as the vehicle to address the learning needs of these students; Bruner (1964), for one, contends that the introduction of technology and multimedia techniques is accompanied by development of thinking skills. If the visual image bears a direct resemblance to either an external object or to the concept of an object or event, it should enrich the learner's store of cognitive images and operations. Video images serve as an additional symbol system to aid in decoding the concepts being taught by more traditional media in the middle school classroom.

Research on the effectiveness of instructional technology has in the past been inconclusive; however, recent studies suggest that multimedia approaches including videodiscs may be motivational and effective at keeping students on task. Anderson and Lorch (cited in Wittrock, 1986) found that children attend to televised material that is comprehensible to them. The closer the match between the communicational symbol system and the task-specific representations, the easier the instructional message is to comprehend. A well-designed multimedia approach should improve cognitive development in middle school children, both by enriching their understanding of the concepts presented and by enhancing their motivation to learn. This hypothesis provides the basis for the two multimedia-based lesson plans to be described in this paper.

A Multimedia-Based Social Studies Lesson

A sixth grade social studies lesson plan using slide presentations and interactive video interlaced with the adopted text was prepared and presented to preservice elementary teachers. The lesson, entitled "The French Revolution," was taken from the sixth-grade textbook *The World* (Graham, Tyler, Messick, Cherryholmes, & Manson, 1988). Objectives for the lesson and vocabulary words to be taught were selected from the teacher's manual.

The text was first read carefully and key information to be learned was summarized. Since the lesson concerned the reign of Louis XIV, a timeline giving significant details of this reign and that of Louis XV was developed to give the students necessary background information; 35-mm slides of Versailles, Fountainbleu, and the castles of Louis XIV, Louis XV, and Louis XVI were selected to illustrate the great difference between the lifestyle of the nobility and that of the third estate; and a *HyperCard* stack was developed for lesson presentation that included selected frames from the *Western Civilization Videodisc* (Reardon & Smock, 1991) and maps of France. The frames were selected to give an overview of the period and to enhance understanding of the text material.

The lesson begins with a presentation of the timeline as it stood at the end of the previous lesson and a concise summary of the reign of Louis XIV. The objectives of the lesson are next given, followed by a videodisc-based overview of the relevant period of European history. As part of the overview, maps of France in that period are viewed and areas of the country mentioned in the text are located and discussed, and significant events of the period are presented by the teacher and added to the time line. The slides of the castles are then shown and discussed, and portions of the text are assigned to be read. Following each reading one or more videodiscs depicting, explaining, or reinforcing the text are shown and discussed and the time line is augmented and finally completed. Following the presentation a semantic web is constructed by the students under the teacher's guidance comparing social and economic conditions leading up to the American Revolution with those leading up to the French Revolution. The original version of the lesson was presented to a college class of twenty-seven preservice elementary teachers exactly as suggested in the teacher's manual that accompanies the text. The teachers were asked to react to the following four questions:

(1) Was the background information given in the teacher's manual sufficient for you to read and understand the text?
(2) Do you think the information would keep the interest of 6th grade students?
(3) Was this the way you were taught?
(4) Have you suggestions for improvement? If so, please state.

Table 1 shows the result of the survey. The teachers largely agreed that the text-based lesson conformed to the traditional mode of instruction and that it would not keep

Table 1. Evaluation of teacher's manual lesson demonstration.

Questions (N=27)	YES	NO	Yes with note taking
Was the background information given in the teacher's manual sufficient for you to read and understand?	27		
Do you think the information would keep the interest of 6th grade students?	4	22	
Was this the way you were taught?	18	2	7
Have you suggestions for improvement?	27		

the interest of sixth grade students. Twenty-eight suggestions were given for ways to improve the method of instruction as presented in the teacher's manual. Eleven of the suggestions concerned the addition of films or other visual enhancements before or during the text reading assignment.

The multimedia-textbook lesson was then presented to this class and to a second group of preservice teachers in a science and social studies methods class. Each group of teachers evaluated the multimedia lesson by ranking the following questions 5-1 (very much - not at all) on a Likert scale. Table 2 shows the results. Both classes rated the lesson positively, with the stronger rating coming from the class that had previously worked through the original text-based lesson.

A *Hypercard*-Based Science Lesson

A *HyperCard*-based science lesson plan for sixth graders was designed to provide an alternative teaching strategy for middle school teachers. The lesson utilized a discovery-based Concept Attainment strategy developed by Joyce and Weil (1986) from the work of Jerome Bruner (1964). The students are first given examples and nonexamples of a concept. They list, compare, and contrast the attributes of each group, and then formulate and test a hypothesis regarding the nature of the concept. If the hypothesis fails the test, the hypothetical description of the concept is refined and retested. Once the hypothesis survives the test, the teacher labels the concept the students have described.

The Concept Attainment strategy can help students "Recognize and recall examples and definitions of key concepts; use evidence to form and test hypotheses; separate relevant from irrelevant information; and correctly explain and apply key rules, definitions, and concepts" (Silver, Strong & Hanson, 1987). In addition, the strategy is effective for middle school students because it accommodates the use of several study techniques taught at this level. Observational techniques can be refined by an observational guide sheet as the teacher presents positive and negative examples of the idea; an advanced organizer can be used by the teacher in lesson development and completed by the student to be included in a study guide; and note-taking skills are reinforced.

The lesson plan was developed by first identifying the concept to be attained. The Louisiana State Curriculum Guide (1990) for elementary school science was examined to select a concept taught to the sixth grade students. Performance objectives were written for the lesson and an advanced organizer developed to help in selection of examples and nonexamples, and *HyperCard* stacks of frames showing examples and nonexamples of Freshwater biomes were prepared using *The Bio Sci II Videodisc Image Database for Biological Science* (Clark, Brocco, & Taylor, 1990).

The purpose of this lesson is to show preservice and inservice teachers that interactive video technology can facilitate the efficient and effective use of a variety of teaching strategies. The hypercard stack takes time to develop but once completed, it can be an invaluable tool

Table 2. Evaluation of multimedia presentation.

Questions	Section I (N=27)	Section II (N=26)
Does the multimedia presentation reinforce the text?	4.88	4.50
Does the multimedia presentation provide information?	4.93	4.23
Does the multimedia presentation increase interest?	4.78	4.12
Does the multimedia presentation interest sixth graders?	4.59	4.15
Does the multimedia form of lesson help attain the lesson objectives?	4.62	4.27

for teaching and aid to learning.

At the time of this writing the lesson has been developed but not evaluated. During the spring semester of 1992, it will be evaluated in undergraduate and graduate classes of preservice and inservice teachers. The focus of the evaluation will be on the effectiveness of the lesson in teaching individual concepts and on developing thinking and study skills.

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Preservice Teachers Integrate the Computer in Curriculum Development

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Abstract

A Curriculum and Evaluation course for secondary level preservice teachers at St. Edward's University is designed to emphasize the use of technology in curriculum development. Modules that incorporate technology include course and unit plans, evaluation and selection of software, a self-paced multimedia lesson plan; a cooperative lesson plan, an interdisciplinary lesson plan, and a multimedia lesson plan using *Linkway*. Other modules incorporate telecommunications and teacher time savers. The course is essentially self-paced with some required class attendance sessions for guest speakers, and technology demonstrations. Students must meet a minimal 70% mastery level on 15 required modules.

Rationale

With the present efforts of the education community to narrow the gap between the school and the real world comes an increased emphasis upon the use of technology in the classroom. Technology may enable the classroom teacher to devote more time to planning for instruction, both alone and in cooperation with other teachers. Students then become active participants, interacting with other students, teachers, and technology. For preservice teachers to be prepared for this new role, they need to (a) experience instructional methodology similar to that which they may later use and (b) develop curriculum that integrates technology and ensures that their own students are active participants in the learning process. The revised curriculum development course for secondary preservice teachers at St. Edward's University is an attempt to provide prospective teachers with the kinds of experiences and training that will enable them to teach effectively in today's classroom.

Introduction

In the spring of 1991 the School of Education at St. Edward's University received an IBM grant that provided a networked computer lab to be used in the training of preservice teachers. The university curriculum courses at the elementary and secondary levels were designated to incorporate the lab. During the summer of 1991 the instructor of the secondary level curriculum course, with the assistance of a former teacher educator at the University of Texas at Austin, prepared self-instruction modules to use in the computer lab setting. The revised course was offered in the fall of 1991 on an experimental basis. Students critiqued materials and activities, making recommendations for course improvement. This student feedback will be used in revising the course.

Course Content

The objectives for the Curriculum and Evaluation course were as follows:

At the end of this course, you will be able to:

1. Demonstrate a knowledge of the historical perspective of curriculum in the United States.
2. Articulate your own concept of an "ideal" curriculum.
3. Develop curriculum for the traditional classroom.
4. Develop curriculum appropriate for individualized, self-paced instruction using multimedia.
5. Adapt curriculum for special populations in the classroom.
6. Acquire computer skills that will enable you to teach effectively in a school that has integrated technology into the curriculum.
7. Be familiar with and critique/select software in your field.
8. Work effectively in groups to develop curriculum integrating software in your subject field and across disciplines.
9. Develop cooperative learning activities incorporating technology.
10. Design a plan for use of telecommunications in the classroom.
11. Design a plan for use of multimedia in the classroom.
12. Work with computer data bases, grade book, test design, or desktop publishing. (as time allows).

Seventeen self-instructional modules were developed to be used by students in mastering course objectives. The first computer module focused upon the responsible use of the computer, how to set up a class, and how to access programs on the network. Other technology-focused modules required that students: evaluate software; select software they would like to purchase for instruction, justifying each selection; create a self-instruction module that incorporated a computer activity or program; develop a cooperative learning lesson around a computer program (group project); design an interdisciplinary lesson plan across two or more subject areas (team or group project); and design a multimedia lesson plan using *Linkway* (individual or team effort). One module required students to use *LANSCHOOL* and to explain how they would incorporate it, *PSIMET*, and/or other telecommunications programs in their own classes. Two extra credit modules allowed students to create a newsletter using desktop publishing, set up a grade book, develop a quiz, use spreadsheets, and develop a multimedia lesson plan using a laser disc. Students used *Microsoft Works* on the network, or they used their own computers when developing unit and course plans in their respective disciplines.

Procedures

Although the course was essentially self-paced, certain class meetings were required. These included activities such as orientation to the course, video presentations, student oral reports, guest speakers, demonstrations of technology applications, and the viewing of programs such as *PALS*, a touch-screen adult literacy program.

Students had to meet all objectives in 15 of the 17 modules to a minimum 70% level. Unacceptable work was revised and resubmitted to the instructor without penalty. Students had to retake any failed quizzes. The development of the course plan generally required that the students master objectives sequentially, but computer lesson plans involving self-paced instruction, cooperative learning, interdisciplinary instruction, and multimedia could be completed out of sequence. Team and group efforts sometimes required students to collaborate on more than one module at a time. They selected their own partners and teams to work on modules that required cooperative effort. Some unusual and creative interdisciplinary lesson plans emerged from providing this freedom, including the following subject combinations: Spanish and mathematics; business, English, and history; economics and mathematics; Spanish and political science; business and mathematics; English, government, and history.

Students used software on the network and diskettes provided by the instructor. Because many of the IBM network programs were in mathematics and science, the instructor found it necessary to acquire software in other subject areas. Some programs such as the *Carmen San Diego* series and *Oregon Trail* were purchased; others such as *Timeline* were acquired as freeware. The instructor appealed to software companies for help. Two companies forwarded software for students to use: one company sent software on 120-day loan; another provided free software that did not have to be returned. The instructor also acquired numerous software catalogs at national conferences on technology that students used when compiling their software "wish lists." When critiquing a program on the network or on one of the acquired diskettes, students completed a form found in their textbook *Classroom Applications of Microcomputers* by Robert V. Bullough and La Mond Beatty.

As students successfully completed activities in each module, the instructor checked off the activities on checklists and placed the graded assignments in individual student folders. If they needed to revise and resubmit an assignment, they began work on it during the class period. Any students working on or ahead of suggested timelines were excused from non-required classes; students who fell behind the designated timelines attended class where they could get help from the instructor as needed. The coauthor of the course assisted the instructor with these in-class help sessions. Staff members from the Computer Center were available to assist in demonstrating how to use various programs and to intervene when there was a technical problem. The computers in the Computer Center are also on the IBM network, providing additional computers for students when the classroom lab was not available. A third IBM lab will be networked in the spring of 1992 to facilitate access to computers.

Problems Encountered

Several problems were encountered in the fall of 1991:

- Need for basic computer science course. Although a computer science literacy course is a prerequisite for the curriculum course, the literacy course does not specifically address the technology needs of classroom teachers. Because of time limitations, the curriculum course cannot incorporate some of the computer training needed by the classroom teacher (for example, gradebook preparation, student data file management, and desktop publishing). A basic computer science course designed for preservice teachers is needed so that students are ready to move sequentially into use of technology in curriculum development.

- Uneven quality of instructional modules. Considerable revision will be needed to make the modules more useful to students. Some of the modules include too much detail, others not enough. Some course revisions will be made between semesters, and a thorough revision will be forthcoming during the summer of 1992.

- Lack of computer software. The network software for the secondary level was predominantly related to math and science. Acquisitions in other subject areas do not presently meet all student needs. Software purchases will be made as the budget allows.

- Lack of access to computer laboratory classroom. The laboratory classroom was used by other departments at the University to the extent that students had difficulty scheduling lab times that were convenient for them.

- Lack of instructor training in complex technologies. While IBM has offered some basic seminars in *Linkway*, there have been no training sessions for desktop publishing or multimedia using laser discs. More staff development for university instructors is needed.

- Varying student needs. While self-pacing proved advantageous to most students, a few students' learning styles did not mesh with this methodology or they lacked the self-motivation and self-discipline needed to meet course timelines. Ideally, students could choose from a selection of instructors and methodologies, but at a small university this flexibility is not possible. In revising the course, the authors will try to incorporate some alternative learning activities for students who prefer a lecture-discussion format, perhaps scheduling small group sessions to accommodate those students who feel the need for more direct instruction than the course now provides.

Implications for the Future

As public schools acquire more technology, teachers will be expected to have the skills needed to develop curriculum integrating technology in the classroom. They should be able to assist their students to use technology effectively and to be able to relate their newly-acquired skills to their future careers. Preservice teachers need to understand how technology can benefit them and make their work easier. Some basic computer courses focus upon programming and basic knowledge of computers and do not address technology needs of the classroom teacher, such as evaluation and selection of software, copyright laws, telecommunications, or ability to integrate technology when developing curriculum. Moreover, some teachers have a fear of technology, preferring to use instructional methodologies that ignore technology.

If preservice teachers can become comfortable with technology and later can use it effectively in their own classrooms, they can become models and even mentors for assisting inservice teachers who have minimal experience using technology. As schools restructure for more collaboration, there will be an opportunity for sharing of knowledge and skills among teachers within and between disciplines.

St. Edward's University is fortunate to be a member of an IBM Consortium consisting of four colleges and universities in the Austin, Texas area. Regular meetings are scheduled that provide the opportunity for IBM staff and college university consortium representatives to meet and discuss problems and share information. Networking beyond the consortium level is needed so that teacher educators within the state and throughout the nation can share problems and information. Model teacher education programs should be identified and there should be an opportunity for the sharing of ideas and dissemination of materials. Perhaps telecommunications will become the medium through which such networking can occur.

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A Computer-Based Curriculum and Instruction Course

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Abstract

The integration of computer technology and the teaching of physics was adopted as the basis for the development of a Physics Curriculum and Instruction course. The course was designed for physics majors, most of whom enter the course with at least a modest degree of computer literacy. Computer technology is used in the course in three ways: as a supplement to the presentation of the lecture component of the course, as an instrument of physics classroom instruction both in the theory and the laboratory components of the curriculum, and as a professional tool. The computer is used in some fashion in virtually every meeting of the class, either by the instructor or by the students. On the basis of three years of trial and development, it appears that the adopted approach promotes favorable attitudes toward the utilization of computers in the teaching of physics.

Introduction

Computers have the potential for changing the way in which science is taught. Realizing this potential requires training teachers to use computers to do those things that computers do well. Fifteen years ago, the introduction of computers into education generated questions like "Should we get computers?" and "How should we use computers?" Today it is clearly just a matter of time before every teacher will be expected to access computer technology. Concerns expressed by student teachers that computer-based training may be irrelevant for them are simply no longer valid. This paper describes one approach of orienting and preparing physics student teachers to use computer technology in the classroom. The purpose of the paper is to stimulate other approaches, suggestions, discussion and feedback.

Commitment to Computers

The issue of commitment to utilize computer technology is one that must be addressed at the teacher training level. In a recent article, Kay (1990) asserted that "without educator commitment, it is unlikely that computers will be used effectively, if at all, in the classroom" (p. 300). Kay found that neither computer experience nor programming skill were significant predictors of student teacher commitment to the classroom utilization of computers. The three attributes that were found to be the best predictors were cognitive attitude, computer awareness, and application software ability. Lesser predictors were affective attitude, locus of control, and gender. If the computer is ever to fulfill its promise as a learning medium, teacher training programs must ensure that these attributes are developed by all student teachers. One way to reach this goal is to train student teachers in a manner that they perceive computers as integral parts of their teaching strategies and professional activities. To investigate the viability of this idea, a Physics Curriculum and Instruction course has been developed which attempts to integrate computer technology with the teaching of physics.

Many unsuccessful attempts at the introduction of educational computing can be traced to human factors, both of teacher and student. Hardware acquisition is not equivalent to curricular innovation. Bresler and Walker (1990), for example, emphasize that an innovation will not succeed unless it fits the patterns by which the teachers and students run their lives. They highlight the crucial role of incorporating the computer within required versus voluntary curricular activities. Innovation requires teacher change at three distinct levels: (1) the actual use of the computer; (2) change in teaching approaches; and (3) change in beliefs (Fullan, 1982). The Physics Curriculum and Instruction course has, as part of its goal, the realization of these changes.

Students

Secondary teacher education at the University of British Columbia consists of a twelve-month post-baccalaureate program that combines elements of curriculum and educational theory with a thirteen-week, school-based practicum. All students registered in this program as physics majors must have a Bachelor of Science in physics or the equivalent, such as a Bachelor's degree in Engineering. These students are required to complete the Physics Curriculum and Instruction course in the fall term of their program. Typically, the class enrolls about ten students per year. The small class size and the homogeneous background of the students combined to produce what was judged to be an ideal situation in which to experiment with the implementation of computer technology.

Most of the students who enroll in the Physics Curriculum and Instruction course enter it with a fairly high degree of computer literacy. However, this literacy is usually restricted to mainframe programming skills, a little laboratory data acquisition experience, and some word processing skills. These students possess, at best, just one of Kay's (1990) three commitment predictor attributes—a positive cognitive attitude. Few possess any awareness of how the computer can be integrated into the teaching of physics or any knowledge of the applicable software. Nearly all of the students enter the course firm in their belief that the high cost of computers will prohibit their general classroom use for many years. A second goal of the course is to seriously challenge this belief.

Equipment and Facilities

All of the lecture material for the one-semester course has been transferred either to *Hypercard* stacks or *More* outlines. For presentations in the classroom, a Macintosh computer is used with a projection panel. A movable cart containing the computer, an overhead projector, the projection panel, and a scanner provides the means of using the computer as a display unit both in the physics laboratory where the course is normally taught and in a computer lab across the hall to which the class is frequently moved. This lab contains eight Macintosh Plus computers, one IBM computer, and a laser printer all networked to a Macintosh SE server. This lab is open to the students outside of classroom hours. In addition, a larger Macintosh SE lab is available in the building on a 24-hour basis.

Since the purpose of the course was to promote the use of computer technology, the use of exemplary software was deemed to be critical to its success. A folder of selected, physics-related software has been added to the server connected to the small lab of Macintosh computers. Included in the physics package is *LXR* accompanied by a school-prepared test bank and a bank of prototype physics questions, *MakeTest* with the *Conceptual Physics* test bank, *Interactive Physics*, *CricketGraph*, some physics related *HyperCard* stacks including the *Essence of Physics* stacks written to accompany Ohanian's *Physics*, *Workshop Physics* Curricular Materials, and the *Physics Explorer:One Body* program from Wings for Learning. In addition, *Microsoft Works*, *HyperCard* and *SuperPaint* were available on the server.

Curriculum and Instruction in Physics

The introduction of computer technology into the Physics Curriculum and Instruction course at the University of British Columbia (UBC) has evolved over a three-year period as time and resources permitted. In the first year, all lecture material was transferred to computer format for class presentation. The students were introduced to using the Macintosh computer to prepare classroom materials, overheads, lesson plans, and unit plans. These activities were all word processor-based. In the second year, the use of the Macintosh to prepare exams and answer sheets was added. The characteristics and use of physics shareware was also examined. In the third year, simulations and lab-based applications were added to the curriculum. At present, computer technology is used in the Physics Curriculum and Instruction course in three ways: as a supplement to the presentation of the lecture component of the course, as an instrument of physics classroom instruction both in the theory and the laboratory components of the curriculum, and as a professional tool. The computer is used in some fashion in virtually every meeting of the class either by the instructor or by the students.

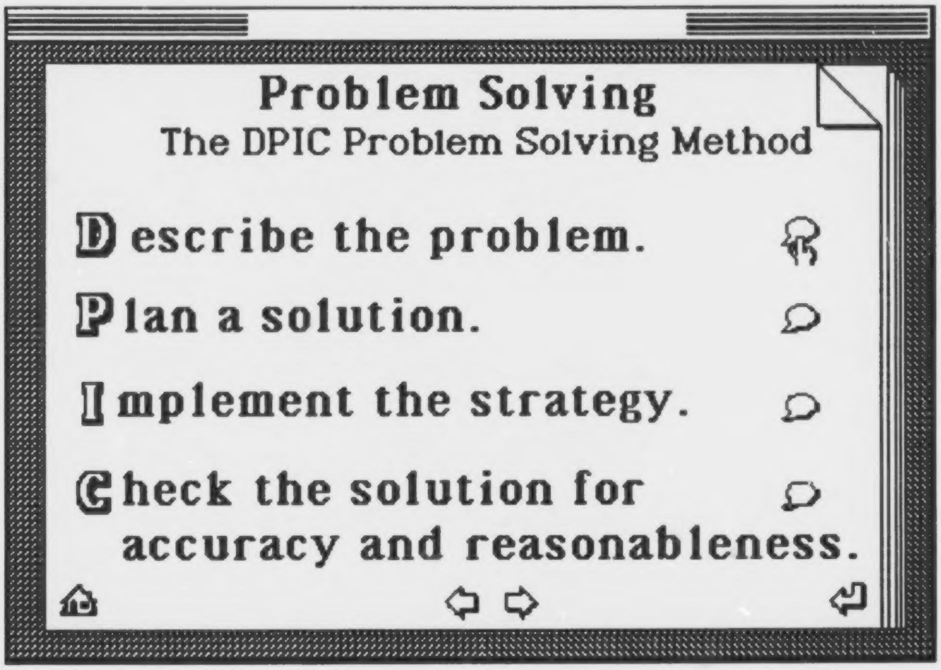
Lecture Presentations

The lesson packages were first prepared using versions 1.0 of both *HyperCard* and *More* but all have since been transferred to the latest versions of both programs. The font manipulation capabilities and clip-art libraries make version 3.0 of *More* particularly useful for the preparation and presentation of lecture material. The lesson packages are accessed and displayed during the lecture and students are provided with printed copies of abbreviated versions of this material as a lecture summary. For the lessons that are presented using the *HyperCard* format, the students are provided with printouts containing eight cards per page. Since the stacks are prepared using a large font size suitable for classroom presentation, the print on these reduced-sized cards is easily read. Buttons are used on the cards to access material point by point so that the printed cards contain headings only with space for students to make notes as additional data are revealed and discussed. One problem inherent in this procedure is that the cards are printed in the order that they are stored in the stack, and not necessarily in the order that they are presented to the class. This problem is particularly troublesome when the stack contains many examples and there is a lot of switching from card to card.

The procedure of distributing lesson summaries was adopted to encourage interaction among the students and the instructor, an activity that is reduced if students are busy taking notes. The emphasis of the Physics Curriculum and Instruction course is radically different from that which the students have encountered in their previous content courses and new procedures for learning, cooperation, and interaction are an important aspect of the course.

Some of the examples used to illustrate concepts presented in the lectures are in the form of overhead transparencies. To present these materials on the overhead projector, a Lucite stand is used to raise the level of the transparencies just enough that the projector focus does not require adjustment when the projection panel is removed. This simple stand has contributed enormously to the ease of using the projection panel in the classroom.

The development of the *HyperCard* stacks was done, in part, to investigate how to program this software and to explore its capabilities as a presenter package. However, *HyperCard* stacks took much more time to develop than the *More* outlines. One procedure that was adopted to reduce the development time of the *HyperCard* stacks was to use the same card format and general structure for each lesson stack. An example is shown in Figure 1. The advantage offered by both *Hypercard* and *More* is the ease with which material can be adjusted, edited, and revised. In fact, it is difficult to resist the temptation of expanding each lesson package beyond the quantity of material that can be effectively presented within the



Problem Solving

The DPIC Problem Solving Method

Describe the problem.

Plan a solution.

Implement the strategy.

Check the solution for accuracy and reasonableness.

Figure 1. A sample of the card format adopted for the Hypercard™ stacks.

allotted class time.

One consequence of using the computer to present lecture material is that the material can be presented in a neat, organized and attractive format—a format that sets a standard for the student teachers. The same is true of the computer-prepared class handouts and visuals, which serve as models for the materials the student teachers will be expected to produce for class assignments and in their teaching.

Physics Classroom Instruction

Physics courseware that provides an interactive environment that can be related to real experiments offers great potential for engaging students in meaningful learning activities (Salinger, 1991). A new feature added to the Physics Curriculum and Instruction course this year was an introduction to the use of physics courseware. The two forms of courseware selected for this purpose were Microcomputer Based Labs (MBLs) and simulations.

Three kinematics MBL software packages were used in the course: (1) the *Universal Lab Interface*, *MacMotion* [Tuffs] software for the Macintosh, and the *Untrasonic Motion Detector*, all from Vernier; (2) PASCO's *Smart Pulley* and accompanying software for the Apple IIGS; and (3) PASCO's air track, photogates, and an Apple II software package called *Basic Mechanics*. Using this equipment and the traditional PSSC timers and ticker tape, the same constant velocity lab was performed four different ways. The results, advantages, and drawbacks of each method were then discussed and the current research on MBLs was presented.

Microsoft Works and *CricketGraph* were introduced as a means of enabling students to analyze and present data for labs for which MBL software is not available. Students master *Works* quickly so it is a source of continued annoyance that *Microsoft* persists in configuring its plotting packages so that they are unsuitable for plotting scientific data. *CricketGraph* is more sophisticated than required for simple lab analysis and not easily mastered, making it an unwise choice both for school use and for introducing student teachers to the educational applications of computers. Vernier's new student oriented *Graphical Analysis* software for the Macintosh will replace *CricketGraph* on a trial basis next year.

Computer simulations have been termed the "rescuers" of classroom computer use, the vehicles that may unlock the promised educational potential of computers (Crookall, 1988). Through simulations, science students can undertake experiments normally considered impractical or impossible to conduct otherwise (Barnato and Barnett, 1981). Computer-based simulations can provide efficient, effective, and highly motivating instruction (Reigeluth and Schwartz, 1989). They have the power to focus the learning environment while leaving control and responsibility for the learning task with the student.

The use of computer simulations constitutes a new instructional technique for most student teachers. Two simulations incorporating similar content, *Interactive Physics* and *Physics Explorer: One Body*, were introduced to the students in the course. The powerful engines of these simulations make it possible for users to learn physics both by interacting with canned demonstrations and by designing their own experiments to simulate the fundamentals of Newtonian Mechanics. Both are versatile and easy to use. The course focused on the use of these simulations both for demonstration and simulation purposes as part of a lecture/discussion and as a student learning tool.

Professional Tool

The Physics Curriculum and Instruction students are introduced to the computer as a professional tool through its use in the development of lesson and unit plans. Within the first week of classes, they complete an exercise that highlights the basic features of *Microsoft Works* and start on a computer-based assignment in class. Their first assignment is to respond to a series of questions related to the British Columbia physics curriculum. This assignment is designed to encourage the students to work in pairs with one knowledgeable Macintosh user per pair. This procedure accomplishes two purposes: the students quickly learn to use the computer, and they quickly get to know each other. All course assignments must be completed on the computer. Examples of computer-generated materials suitable for classroom use are introduced throughout the course (Woodrow, in press). As the term progresses, the students become noticeably more proficient at formulating their own material. At the end of the course, the students put copies of their assignments on the server to be shared by their classmates. As an incentive to do this, each student is assigned a specific section of the curriculum and prepares materials related to that section for each assignment.

Near the end of the course, the students are introduced to the techniques of creating and accessing data banks of exam questions and of creating exams from existing databanks. *LXR* was chosen for this purpose since this software is used by many teachers in the province and by the ministry in the construction of government exams. This year, the software *MakeTest* was also shown to the students as an alternative to *LXR*.

Throughout the Physics Curriculum and Instruction course the students are encouraged to examine the other packages of physics-related curriculum material that are on the server in the small Macintosh lab, but these materials have not yet been formally introduced into the course.

Discussion

It is apparent that the approach adopted for the computer-based Physics Curriculum and Instruction course promotes favorable attitudes toward the utilization of computers in the teaching of physics. Students progressively move from a stage of skepticism about the educational value of computer technology to one of cautious consideration of its potential. To help the students appreciate the changes that have occurred in the state of computer technology in secondary schools in the last five years, examples of computer-generated classroom resources, exam banks and labs prepared by local physics teachers are regularly mentioned and introduced in the course. These examples bridge the gap between theory and reality for many of the students. Students are also assured that the level of computer resources presently available in many local school districts is presently, or will shortly be, more than adequate to replicate the class examples.

Features have been added to the course gradually over a three-year period. The small Macintosh lab, for example, was a new and welcome addition to the department's facilities this fall. In prior years, it had been necessary to book time in the larger lab at the beginning of the semester and ensure that the necessary software was available each time the students were to use the lab. Course flexibility was severely impeded by these restraints. By having the small computer lab under the direct control of the science education department, the process of installing and checking software was simplified and easier to monitor. Competition for use of this facility is also much less than for the larger lab, at least for the present. The one notable disadvantage of the small lab was the slow operation speed of the Macintosh Plus computers. This problem was most acute when the simulation packages were being run from the server. As a temporary solution to this problem, copies of the simulations were placed on the computers' hard disks and removed at the end of class. This solution was not entirely satisfactory since the the slowness of the computers was still evident. An upgrade to faster computers for this lab is currently being negotiated.

Conclusion

The course has now been offered for three years. All of the students who have taken the course have had the requisite skills to handle the demands that the approach presented. Even the few students whose level of computer literacy was gauged to be low were not overly anxious about using the computer-based approach. Since the aim of the course is to develop teachers of physics, not teachers of computers, mastery of the various software packages is not an objective of the course. However, by the end of the course, all of the students were able to use the computer as a tool for the preparation of classroom resources, exams, worksheets, reference notes, lesson plans and unit overviews, and knew how to use it as a teaching tool for the presentation of lessons, the demonstration of physics concepts, and the performance of physics labs. One measure of the impact of the approach is encapsulated in the student remark, "I never thought of using a computer that way."!

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TEAMSS: Staff Development for Middle School Science Using Hypermedia

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Abstract

This paper describes a cooperative teaching and learning staff development model to improve middle school science teaching. The model emphasizes a team approach, computer-aided hypermedia technology, and reflective practice. Teams composed of a science coordinator, master teacher, and novice teacher develop classroom materials and prepare inservice training packets for their colleagues, working collaboratively to expand their content knowledge and technical skills.

Background

Education faces a number of challenges: Foremost among them is providing and maintaining sufficient numbers of qualified professional staff, particularly in the critical area of science. Each year, fewer college graduates with degrees in science pursue a career in teaching; the effect is that fewer than half of the novice science teachers across this country possess certification in their subject area.

Knowledge gaps often occur, even among those certified to teach and those with experience. Busy schedules limit teachers' access to appropriate staff development opportunities for upgrading knowledge, skills, and understanding of current advances in science, technology, and pedagogy. The traditional conditions of teaching, which often isolate staff members from one another, inhibit the development of collegiality and collaborative decision-making so necessary for professional growth. As school practitioners cope with the stress of working in isolation from other adults and respond to the current demands of multiple reform agendas with increasing administrative duties and role responsibilities, they often experience burnout. The combination of isolation and burnout frequently causes many teachers to leave their profession at the very time that their skills have become highly developed and their potential is the greatest. This situation further aggravates the acute shortage of qualified teachers at all levels of education, particularly in science.

TEAMSS: A Model of Staff Development

In response to the challenges stated above and proposed guidelines for providing staff development to revitalize science education (Loucks-Horsley, 1990; Loucks-Horsley, et al 1990; Sparks, 1989), two professors at George Washington University have developed a model of cooperative teaching and learning that uses a team approach and computer-aided hypermedia technology to improve science teaching and increase professionalism among science educators. Teaching Enhanced Applications for Middle School Science Using Videodisc and Hypermedia Technologies (TEAMSS), funded by the National Science Foundation, was planned to identify outstanding middle school classroom science teachers; establish linkages between them, working scientists, science resource specialists, and university professors; and support planned activities over a year that can individually and collectively foster professional growth, expand knowledge, skills, and understandings, and encourage reflective practices among science educators.

The TEAMSS project incorporates three major activity components designed to take advantage of local and regional resources: (a) a four-week intensive summer workshop that involves technology training, lecture-demonstrations, hands-on computer lab experiences, and team project development; (b) a summer shadow-a-scientist program; and (c) school year follow-up activities including team meetings, teacher implementation of science lessons and curriculum projects developed in the summer, teacher-planned and developed inservice presentations to their home schools, Saturday sessions, site visits by the principal investigators, and individual participation in a regional science education conference.

TEAMSS philosophy

The TEAMSS philosophy is based on an understanding of staff development as a dynamic and continuous learning process for individuals that must be sustained and strengthened by appropriate administrative and peer support in schools and in districts (Loucks-Horsley, 1984). The program is predicated on a constructivist view of learning with the cognitive development of the adult learners (teachers) requiring that they beprovided with a multiplicity of experiences from which they can construct their own meanings and explanations. Respect for participants as adult learners dictates that innovations not be imposed, but rather that the outside intervention create an atmosphere conducive to reflective practice where individuals and groups cooperatively explore such innovations to determine what they mean for them personally.

TEAMSS Objectives

Throughout all of the program activities, five objectives are interwoven:

1. to build teachers' technology skills
2. to enhance content knowledge in life sciences, in the pedagogy of cooperative learning, and in the middle school concept
3. to increase awareness of science, education, and technology resources
4. to promote the integration of new skills and content
5. to increase and strengthen professional relationships of education colleagues and scientists.

TEAMSS Membership

In the first year of the project, participants included fourteen teams of three, each consisting of a science coordinator, a master teacher and a novice, drawn from public and independent school systems in the greater Washington, D.C. area.

TEAMSS Evaluation

The naturalistic inquiry research approach was the methodology selected to understand the on-going processes of staff development and to determine the quality of the TEAMSS program, its impact on the participants and their home schools, and the extent to which each of the five objectives has been achieved. The primarily qualitative data obtained from multiple data sources (daily evaluation sheets, daily learning logs with directed and free writing, observational field notes, informal interviews, and a formal project evaluation form) at different times during the year can be synthesized to convey the relationship among multiple perspectives. Following are some observations and preliminary findings of the data collected thus far.

Daily Evaluation Forms

Administering a daily evaluation form during the summer workshop is time consuming for all participants, taking up a few minutes of program time daily and generating a large amount of data to be processed. Nevertheless, the communiques proved to be most helpful in providing direct feedback as well as some less obvious but incisive insights into the participants' personalities and perceptions related to science, teaching, and learning. The forms enabled us to modify our program on a daily basis and thus better respond to the evolving needs of our students. For example, in the first week of the workshop, the daily evaluations revealed that many participants were experiencing difficulty with the concepts of *HyperCard*. While they refrained from expressing their discomfort publicly during the lab sessions, they forthrightly conveyed the frustrations on the evaluation forms. As a result, we were able to revise our schedule, provide more time in the lab, focus in on those students needing extra direction, and develop additional teaching units for *HyperCard*.

Learning Log

The purpose of having participants maintain an additional journal, or learning log, was to facilitate their personal reflections and evaluations of individual growth. Sometimes participants were asked to write about a particular topic, such as how they felt during a specific cooperative learning situation. Other times, they were asked to contemplate some experiences from the past or imagine a future scenario. They were always encouraged to jot down their reactions to new pedagogical information and to make notes about how they might use the materials in their classrooms. To document and trace their own evolution, the staff members also kept journals and often held open discussions about their responses.

Participants' reactions to the learning log were varied; some students initially resisted writing and only a handful greeted the task with enthusiasm. Some contributing factors to the students' resistance may include science teachers' inexperience and/or discomfort with personal writing, the newness of using the technique of personal reflection, initial concern for privacy of thoughts, and inexperience of the staff in comfortably integrating the learning log within their curricular plans.

Summer Questionnaire: Preliminary Findings

A comprehensive questionnaire evaluating the TEAMSS Program to date was administered to 29 participants on the last day of the workshop. The directions reminded participants of the objectives of the program and informed them that the evaluation sought to determine the quality of the program and the extent to which the summer portion of the program succeeded in meeting those objectives. A review of the findings can be

Table 1: Summary of summer program evaluation

Choice of ratings ranged from 1 (low) to 5 (high)

A.	Administrative Features	
	Administration of Course	4.7
	Facilities	4.6
	Dissemination Materials & Information	4.6
	Application & Acceptance Procedures	4.6
B.	Program Structure	
	Organization	4.4
	Varied, Stimulating Program Elements	4.8
	Logical Sequencing	4.7
	Effective Scheduling	4.4
	Program Balance	4.6
C.	Program Features	
	Upgrade Technology Skills	4.7
	Enhance Content Knowledge in Life Sciences	3.0
	Identify Science, Education, Technology Resources	4.2
	Integrate Skills & Content; Increase Strategies	4.6
	Strengthen Interpersonal Skills & Prof. Relationships	4.7
	Instructional Effectiveness of TEAMSS	4.7
	Profs Modelled Collaborative Teaching	4.9
	Campus Experience	4.6
	Staff Presentations	4.7
	T/A Support	4.9
	Guest Speakers:	
	Library	3.7
	Discovery Channel	4.6
	Multimedia in Science	4.4
	Field Trips:	
	Zoo	4.5
	National Demonstration Lab	3.4
	Cooperative Learning Team Worked Together	4.2
	Team Accomplished	4.7
	Equipment	4.4
	My Mastery	4.5
	Informal Sessions	3.8
	Project Presentations	4.9
	Usefulness and Clarity of Handouts	4.7

found in Figure 1.

Perhaps more informative than the statistics at this stage are the comments made by the participants. They noted unanimously that they would recommend this experience to their colleagues. In comparisons with other staff development programs in which they participated, their ratings ranged from "excellent", to "stimulating and informative, much more in-depth, much more intense!" They suggested that the most useful parts of the experience were learning *HyperCard* and "cooperative learning that allowed groups to develop cohesion."

They stated that aspects of the program needing improvement included the need for more time to reflect and assimilate new ideas; more time for informal, less directed socializing; and more time for hands-on practice in the lab. They identified three program features as average: the guest speaker on the Use of the Library (rated 3.7), the trip to the Smithsonian National Demonstration Lab (rated 3.4), and the Informal Sessions (rated 3.8). Changes suggested by the participants included:

- Provide a more detailed syllabus on the first day with greater clarity in expectations.
- Provide more time to become acquainted on the first day and increase the amount of informal discussion time throughout the program.
- Plan all field trips before the last week.
- Provide more equipment and technical assistance for novices.
- Provide campus residency for all participants to reduce time pressure.
- Encourage greater collaboration and continuing support for each other's professional growth (e.g., by having periodic meetings and establishing a newsletter and an electronic network).
- Experiment with the composition of the teams to encourage more dialogue across schools and across cultures.
- Use the Fellows in the TEAMSS program in recruiting, selecting, and supporting the work of new Fellows through presentations, demonstrations, and technical assistance.

The participants' reflections on the impact of the TEAMSS project manifest a wide range of attitudes from already open to technology and/or cooperative learning to "totally changed my understandings related to small group dynamics" and "changed me from a technophobic to a technology crusader". Several noted that their confidence with computers and multimedia increased greatly. A majority of participants focused on the broadening of their understandings related either to technology or to cooperative learning; several offered remarks related to teaching and learning styles, and a few discussed the changing middle school concept.

When asked about their future as it related to the project, many participants cited plans to improve their classroom instruction by using cooperative learning techniques and/or integrating multimedia and hypermedia. Some comments were passionately expressed, such as "I'm going to be the world's greatest software developer for my class!" or "My increased self-confidence will enable me to continue to learn!" All participants expressed their intention of using technology much more than they had ever used it; one specified that he would incorporate it in different ways—more as a tool to improve the students' thinking than as an attention grabber.

All participants at the first follow-up session appeared positive about what they had experienced; *most remarked that they had applied some aspect of their summer learning*. Even the two teachers whose assignments had been drastically altered (one to a primary grade, the other to teaching a different subject) noted the continuing relevance, applicability, and value of the summer's pedagogical focus on cooperative learning.

Almost half of the teachers reported with great pride successes in incorporating the curricular lessons they had developed and/or in presenting some technology demonstration or inservice training for colleagues, administrative staff, parents in the community, board members, and educational leaders at a Virginia State conference. One team shared a local newspaper story published in early August that included a large photograph with the headline reading, "High-tech learning in progress: Manassas Park teachers prepare for 21st Century."

On the other hand, a significant number of teachers shared their high levels of frustration with the lack of appropriate equipment in their schools; difficulties in trying to acquire the necessary equipment despite the fact that their schools had signed letters of commitment guaranteeing access to it; and a disheartening lack of resources for developing classroom materials and integrating new materials and strategies.

In our application procedure, we had attempted to address the critical need for administrative support in supplying teachers with the necessary time and equipment. Not only was there a signed letter of commitment from the school system guaranteeing release time each month and equipment accessibility, but TEAMSS membership had to include a "science coordinator," who we defined as someone with administrative and curricular duties beyond the classroom. The reality is that (a) many systems defaulted on their commitments, possibly due to economic pressures and (b) most of the participating "coordinators" had only curricular department chair responsibilities and lacked any decision-making power to authorize technology resource acquisition.

Conclusion

A final evaluation report will be prepared after the still-to-be administered mid-winter 1992 phone interviews and the late spring 1992 questionnaires are analyzed. By comparing the views of participants at different stages, we will be able to monitor changes in teaching practice, attitudes and feelings toward teaching, and professional relationships; perceptions regarding the strengths of the TEAMSS Project; difficulties experienced in applying the summer experience; and suggestions for how we might further support the professional growth of teachers and revise the TEAMSS program.

Because the findings recounted here represent a preliminary view, no recommendations are made at this point but rather a series of open questions are posed:

- How should we alter our application process, from advertising and selection criteria to defining the makeup of the TEAMSS?
- How can we involve the real science decision-makers within the TEAMSS?
- What can we do to ensure that the school systems will provide necessary time, training, and equipment and live up to their commitments?

Other questions pertain to any professional development program that requires technology:

- What can we do to institutionalize the positive staff development process we initiated?
- How can we create synergy between the university staff development experience and the district and school operation?
- Should we involve school systems more directly in the processes of programs like ours and more fully integrate staff development program into the school systems' agendas for restructuring and reform? If so, how?

Acknowledgments

The work described in this paper is supported under National Science Foundation Grant TPE 9055370.

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Databases: An Underutilized Resource

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Abstract

Although the use of databases seems to have great potential for supporting the use of higher-order thinking skills in almost any curriculum area, they are not widely used in most classrooms. When they are used at all, they are often only used as fact files (similar to almanacs and reference lists) or as management tools (to document completed "real work," for example). Teacher educators have a unique opportunity to influence the teaching resources of future generations of teachers. Through the practical, authentic use of databases in their classes, teacher educators may begin to help their students realize the full potential of database-supported study of patterns and trends in data related to any curriculum. From software evaluation, to surveys, to bibliographic/resource files, students can be challenged to look for patterns and let the computer assist their study by processing the information with speed and accuracy.

If word processors are the most utilized computer tool in the classroom today (Flake, McClintock, & Turner, 1990), then databases may well be the most underutilized. Although the use of databases and related information and analytic tools seems to have great potential for supporting the use of higher-order thinking skills in almost any curriculum area, they are not widely used in most classrooms. When they are used, the uses are often not the sorts of activities designed to support the development of higher-order thinking skills. Perhaps one of the reasons is that teachers have not been exposed to sufficient examples of practical, authentic uses for databases that will accomplish that objective. This paper outlines potential strengths of databases in classrooms, reviews recent reports of uses of these tools, and proposes database applications that can be meaningfully integrated into virtually any curriculum, including the teacher education curriculum.

Potential Strengths of Databases

"Using databases as tools for learning provides opportunities to focus on learning strategies and thinking skills as well as to explore and discover facts about a particular topic" (Ryba & Anderson, 1990, p. 73). Adams (1992) refers to the database as a "protean tool" (p. 46), suggesting that through the support database management software provides in sorting and searching potentially massive amounts of data, *all* students can begin to deal with significant questions involving patterns and trends. Some of the skills and strategies identified by Hunter (1985) that can be practiced through the use of databases include relating information to one's own needs and interests, seeking different relationships or new ways of looking at things, discovering commonalities or differences between groups of events, synthesizing the answers to subproblems to solve a bigger problem, talking about thinking (metacognition), learning how to articulate problems, and finding ways of explaining clearly. While improving any of these skills would seem to be worthwhile, the idea that most or all can be practiced in the course of working with databases makes the use of these tools particularly desirable.

Current Amount and Types of Database Use

A recent survey of "accomplished" technology-using teachers (Sheingold & Hadley, 1990) reported that 87% of responding teachers use analytic and information tools (72% specifically indicated the use of databases) in their classrooms. Therefore, it seems that databases are widely used, at least in the classrooms of accomplished computer-using teachers. However, only 20% of the more experienced teachers (5 or more years experience) and 10% of the less experienced teachers surveyed indicated *frequent* use of databases (compare with 80% of the more experienced teachers and 60% of the less experienced teachers who frequently use word processing). More than half of the surveyed social studies teachers and almost 40% of the science teachers use databases, although the most frequent application listed by science teachers was word processing.

What are databases good for? Aren't databases only useful for "storing data"? Why do social studies and science teachers seem to find them more useful than everyone else? Surveys of database uses cited in the professional practice literature reveal that many, if not most, of the suggested applications could not be expected to enhance higher-order thinking skills. Many of the activities amount to nothing more than recording results of other activities, with no further database-supported processing beyond data entry and verification. If students are encouraged to "use" their database, it is most commonly in the form of a word-processed report or essay based on a single database record. Simply writing the results on an index card would probably serve the same purpose with less time and effort involved. Using a database as a simple fact file is like using a word processor as a simple typewriter: it provides no exposure to or understanding of the real power of the tool.

Focus on Teacher Educators

Numerous articles in the teacher education literature remind teacher educators of the importance of modeling actions and attitudes that we wish our students to have in teaching (e.g., Chickering & Gamson, 1987; Hollingsworth, 1989; Russell, 1983). James Poirot suggests that "If they [preservice teacher educators] don't use it [technology] in their classrooms, the students they are teaching will, by default, lose an important area of instruction—that is, instruction by example" (Bruder, 1992, p. 149). In a recent survey (Brownell, 1991) of teachers of a first computer education course for educators, 93% of the respondents agreed that databases should be included as a course topic (4% disagreed and 3% "didn't know"), but when asked to rank the importance of topics, the respondents rated databases seventh, below CAI. Interestingly, "Computers and Problem Solving" (an area for which the use of databases seems to be especially relevant) ranked first in importance, even above word processing. No published survey documenting use of databases in teacher education classes is available, but surveys of all undergraduate departments typically show very small database use outside of science and some social science departments.

Can databases be put to authentic, practical use in teacher education classes? What "data" do we deal with in teacher education classes that could be better handled through the use of databases? Several possibilities follow.

Vocabulary/Objective Tests

Test banks and glossaries can be coded by objective, or chapter, and used to provide individualized information, review, and/or assessment. The entries can be teacher-made or student-made.

Bibliographic/Reference/Resources Information

Why have students re-invent the wheel each semester? Begin to develop one or more comprehensive databases of published lesson plans and instructional materials, journal articles, or campus/local resources, categorized by source, location/availability, grade/subject/topic, hardware/software, and other categories of interest. But don't stop there—have students sort, search, and subtotal, looking for patterns and trends in the information contained in the database. Also have them consider and reconsider alternative representations and categorizations to allow patterns to be observed more effectively.

Survey Responses

Don't forget that software evaluation is essentially a survey of the evaluators. Whether your students review software appropriate to a particular subject or student age or software designed for teacher education (such as classroom management simulations, or lesson plan writing tutorials), their evaluations can be stored and used as the basis for analysis of trends. You may also find that student insight into patterns can add new dimensions to your perception of the results of a survey.

Sources for charts and graphs

The accessibility of visual data presentations greatly increases the probability of comprehension of large amounts of data. Every class includes some information that would be more clearly represented for some student in the form of charts or graphs. Most database software either has charting capabilities built in or can be easily interfaced with spreadsheet or charting software to produce these visual summaries.

Fact Lists

Lists of important people, organizations, or developments, can be organized and searched. Looking for trends in location, historical period, etc. can reveal interesting patterns. Although this sort of activity could be done without the aid of an electronic database, when students want/need to deal with large amounts of data, the task can become overwhelming.

Records Management

Every teacher has to manage student records. Whether you teach 15 students or 200, the time required to produce computer-assisted progress reports is a fraction of that required to produce that information by hand.

Closing Words

Margaret Niess (1991) presented the results of a project aimed at identifying a set of competencies necessary for successful computer-using educators in the 90's. After listing and describing the final set of competencies identified for "all teachers," she provides a set of recommendations for preservice and inservice programs to prepare teachers adequately for the 1990s. Her recommendations include provision of a general introduction to computing early in the college preparation of preservice teachers so that they can use computers as learning tools throughout their college program.

She goes on to suggest that teacher education programs must shift from dependence on a course on computers in education to a more integrated approach. "Preservice teachers must have *an education that integrates teaching with computers and related technologies throughout the entire program*" (p. 14). She suggests that as long as computer technology is seen as an add-on to the teacher education program, it will continue to be viewed as an add-on in pre-college education. She challenges colleges of education to reevaluate their curricula in the light of her recommendations.

She further suggests that one of the keys to this proposed integration is that professors must themselves use computers as personal and professional tools. I submit that this use should include databases and related information and analytical tools. When teacher educators become aware of the potential for database-supported study of patterns and trends in their own work, the resulting excitement might just spill over to their students, who will become the next generation of teachers.

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TEACH IT Modules: Reducing the Barriers to Wider Use of Technology in Education

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Abstract

This paper discusses the barriers to integration of technology into the teacher education curriculum and concludes that one major barrier is the requirement that each instructor develop his or her own instructional packages. This barrier could be reduced, if not eliminated, if technology-using teacher educators develop instructional modules for use in their own classes and made those modules available to other teacher educators through a national distribution system. One way to do this would be to publish modules in a Society for Technology and Teacher Education monograph and allow instructors who own the monograph to reproduce the modules and use them in their classes. If the modules are also made available in *PageMaker* files that can be downloaded from Internet, instructors would also be able to modify and revise them to meet local needs and contexts.

More and more colleges of education are requiring a comprehensive course on computers and information technology for all students who plan careers as teachers. The decision to require a course of every teacher education student presents problems, however. First, few universities have enough trained faculty to offer a three-semester-hour educational computing course in the traditional methods course format. Second, if these courses are taught in a large group lecture format the results are often disappointing. The competencies, procedures, and attitudes that typically constitute the objectives of the course are not easily achieved in such a format. Many, in fact, are impossible to realize in courses that rely primarily on large group lectures. Third, the content that is easiest to teach in that format is not necessarily the most relevant or most important content.

The problem of teaching knowledge and procedures that are relatively easy but not very useful to novice teachers is significant. Some introductory courses, for example, deal only with programming in a language like BASIC. A course that deals with BASIC is not difficult to teach; BASIC is provided with virtually all personal computers today. An introductory course for teachers devoted to BASIC or any other programming language, especially if it is the only course on technology they will take, is a poor use of the time. Few teachers, especially beginning teachers, will find the programming proficiency they achieve in one course useful.

Another common approach to content is what might be termed "common computer literacy." By *common computer literacy* I mean the core computer literacy experiences found in many general computer literacy courses—the ability to use the disk operating system for routine tasks, novice level facility with word processing, database programs, and electronic spreadsheets, and an inkling of how these skills might be used by citizens in an information-intensive society. Although common computer literacy skills are useful to teachers, they do not constitute a sufficient basis upon which to build a career as a computer- or information technology- using educator. Much more is required, and courses that do no more than provide common computer literacy training are inadequate.

An adequate course should cover what might be referred to as "profession-specific computer literacy" as well. *Profession-specific computer literacy,* in teacher education, deals with the concepts, theories, and procedures that relate specifically to the *instructional* uses of information technology. Teacher education students should not graduate without an understanding of these instructional uses.

The three problems mentioned above—staffing the course, using effective instructional formats, and appropriate content—interact. Where staffing options are limited it is more difficult to use effective formats because they tend to be labor intensive. Covering profession-specific computer literacy is also more labor intensive and there are fewer faculty members who can teach this aspect of the course than there are faculty who can teach BASIC programming or common computer literacy. Because the three problems are prevalent in colleges and universities today, effective ways of dealing with them would be of interest to many teacher education programs. Effective methods that model the appropriate use of information technology in educational settings would also be very appealing.

The Future: Full Integration of Technology into Teacher Education

Today the typical student in teacher education learns about the use of computers in a separate, stand-alone course. The stand-alone course might best be thought of as the transition phase between no exposure to computers and full integration of technology into the teacher education curriculum. Because technology changes so quickly, there may always be a place for a specialized course on cutting edge instructional technologies. However, much of the content taught in a stand-alone educational computing course today might be better taught in other teacher education courses. Foundations courses might model the use of teleconferencing to facilitate discussion and reflection; methods courses could use simulations and multimedia packages to teach the integration of technology into the curriculum, and so on.

Although full integration of information technology into the teacher education curriculum is a long way off, there are many teacher educators outside the areas of instructional technology and educational computing who are interested in using or teaching about technology in the courses they teach. Many teacher educators have the interest, but mastering the technology well enough to develop lesson plans and activities for the courses they teach is a very labor intensive process. A project that helps new classroom users integrate technology into their courses and also helps established users improve their coverage of technology would be of considerable benefit.

What Do We Need?

Many, if not most, colleges and schools of education have computer labs today and many require students in the introductory educational computing course to spend a significant amount of time in the lab. Students may spend their lab time on many different types of activities from writing simple programs in BASIC to learning *AppleWorks* to running educational software and writing evaluations. Simple programming; word processing, and exposure to educational software are not outstanding profession-specific computer literacy activities. Programming is of limited value to beginning teachers. Straightforward applications skills such as word processing are useful but do little to give the teacher education student a vision of what can be done with computing technology in schools. Previewing software by running it in a college lab, while helpful, separates the software from the crucial curricular and teaching components that determine whether the use of technology is successful or not. Courses in educational computing should include a sweep of experiences that:

1. **Expose students to a range of instructional technology applications**, from drill and practice programs to non-linear information resources such as *HyperCard* stacks and multimedia programs such as interactive computer/videodisc packages. Where possible, lessons that are developed for use in more than one teacher education program should rely on public domain, shareware, widely available commercial software, CD-ROM packages, and laser discs.

2. **Use technology to deliver some components of the course.** We should model effective use of technology. Showing teacher education students a program designed for use in an elementary classroom is fine, but if we expect them to use technology in their classrooms after graduation we should model that use in the college courses we teach. And if we actually model the way information technology is effectively integrated into instruction, we must do more than demonstrate software designed for use in K-12 schools. We must design, develop, and distribute software and multimedia packages created specifically for teacher education.

3. **Model the effective use of a variety of technology and formats.** Where possible, students should accomplish some of the objectives of the courses through well designed drill and practice, tutorial, simulation, hypermedia-multimedia, IVD, and standard video experiences.

4. **Model, or at least illustrate, the educational uses of applications software** such as data bases, spreadsheets, word processing, and telecommunications.

5. **Model, or at least illustrate, a range of technology-supported:**

- *instructional formats* such as lectures/discussions, cooperative learning groups, small group exercises, learning centers, interest development centers, personalized system of instruction modules, modeling, projects, brainstorming-problem solving activities, debates, dramatizations and dramatic recreations, role playing, demonstrations, study trips, exhibits, videotapes, videodiscs, hands-on computer learning activities, peer tutoring/teaching, library/resource center assignments, desensitization, distance education/telecommunications, computer assisted and computer aided learning.
- *instructional strategies* such as advance organizers, graphic organizers, concept mapping, metaphors and analogies, mnemonics, as well as rehearsal, fading, shaping, chaining, dipsticking (initial assessment and assessment of progress and mastery), and imagery. No course is likely to model all these formats and strategies, but any course should model a range of formats and strategies and a comprehensive teacher education program will provide experiences with most of these strategies.

6. **Relate instructional strategies and formats to the underlying theories of human development, learning, and curriculum development** that support them. Individual drill and practice programs, for example, should not be illustrated or used in isolation. They should be related to the behavioral learning theory that undergirds the development of most drill and practice software. Likewise, illustrations of hypermedia could be related to the neoPiagetian, constructionist, cognitive developmental theories of learning that underlie many non-linear instructional packages.

7. **Deliver instruction that is both effective and time/staff efficient.** Because the staffing situation is unlikely to improve in the foreseeable future, where possible, the student should be able to work through activities without close, one-on-one supervision.

Teach It Modules

One way of facilitating the wider use of technology is the development and validation of a series of instructional modules on information technology for teacher education students. Although there would be considerable diversity in these modules all of them could be effective as individual or group activites that occur outside the regular class meeting time. Many, for example, would be used in the college of education computer lab. In the labs the modules might be used by individuals or as guides to group activities. In institutions with very limited facilities, a module might serve as a lecture/discussion guide for the instructor. At the University of Houston we have developed a number of modules in a series named Teach IT—Teacher Education and Computing at Houston—Information Technology Series.

As evisioned a Teach IT module would generally be 5 to 20 pages long and would have the following components:

Overview

- advance organizer

Objectives

Activities

- detailed directions for each activity, supporting text, and illustrations that relate the activity to appropriate applications; where relevant, an overview of theories and concepts

Assessment

- every module would have a means of assessing successful completion

Evaluation

- every module would end with an evaluation form that asks the student to rate its effectiveness and suggest ways it can be improved.

Instructor Suggestions

- the final section would be a set of suggestions for instructors who plan to use the modules. This section would also include information on how to obtain any software/hardware needed to use the module.

If the Society for Technology and Teacher Education develops a series of Teach IT modules, they would be useful at many universities. With an appropriate distribution system potential users could adapt and change the modules to fit local needs and changing technologies.

Distribution format for the TEACH IT Series Modules

A two-level distribution system is planned. First, the Society for Technology and Teacher Education would publish one or more monographs in a Teach IT series. These monographs will contain modules that have been submitted to the monograph editor, and accepted for publication.

An instructor who owns a monograph will have permission to duplicate and use any of the modules in the monograph for classroom use. However, instructors can also adapt or modify a module to their particular course and setting. To make that easy, the STATE Telecommunications Committee, which is chaired by Glen Bull at the University of Virginia, will make the *PageMaker* files for each module available for downloading over the Internet. An instructor who wants to use the module we developed here at UH on using the ERIC CD-ROM to search the educational literature, for example, might download the *PageMaker* file of that module and replace the map of the UH library with a diagram of the location of the ERIC CD-ROM in his or her library. Providing *PageMaker* files will allow instructors maximum flexibility in the use of the modules. Making the modules available over the Internet also solves another problem: how to efficiently distribute any non-commercial supporting software that is required to use a module. For example, some modules might be used with a specially developed *HyperCard* stack or a *Toolbook* book. These programs could be made available over the Internet.

Will I Get Rich If I Create Lots of Modules?

No, I'm afraid not. I see this project as a scholarly endeavor instead of a commercial one. Over the last twenty years publishers occasionally tried to publish modular instructional packages for profit, but none to my knowledge have been successful. There have even been problems getting educational software for higher education distributed. Kinko's project to distribute Macintosh higher education software was discontinued and taken over by Intellimation. The North Carolina State/Duke University Press software distribution projects were not profitable enough to justify their continuation. I think an approach that might work is to treat the creation of a module as a scholarly effort that is evaluated by peers and then published if the module meets reasonable standards. Every module, like every article, would carry the authors' names, but other faculty could reproduce and use the materials without further charges. There would, however, be one proviso. If an instructor sets up a "professor publishing" arrangement with a copy center and charges students more than the standard cost of reproducing the modules, 20% of that additional charge would be due the Society. It would be put in a fund to support further development of modules.

How Do I Participate?

If you're interested in submitting a module to this project, send me a note indicating the topic. The note should, if possible, be an e-mail message.

My address is:

On Internet	jwillis@jetson.uh.edu
On Bitnet	jwillis@jetson

The addresses above can also be used to request copies of sample modules that have already been developed at the University of Houston. Use them as format guidelines, but remember that the monograph editorial staff can add the desktop publishing formatting. Do a great job on the content and we can make it look pretty. When you have your draft of a module ready to submit, send a paper and disk copy (indicate the type of file on the disk) to:

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Some Module Possibilities

Below are some of the possible topics for a module. Most of the modules listed would deal with concepts and procedures through text in the module and hands-on practice or exploration at the keyboard of a computer.

- A Behavioral Analysis of Good Computer Use in the Classroom
- A Cognitive Analysis of Good Computer Use in the Classroom
- A Constructivist Analysis of Good Computer Use in the Classroom
- Automated Test Development, Administration, and Scoring
- Computer Integration in Math (or Geometry, Calculus, Algebra)
- Computer Intensive Adult Literacy Programs
- Computer Managed Instruction from the Teacher's Perspective
- Cooperative Learning: Roles Technology Can Play
- Creating Computer-based Presentations for Classroom Use
- Databases and the Social Studies (or History, Zoology, Ecology, Health Ed.) Classroom
- Desktop Publishing for the Educator
- Developing a Lesson Plan that Integrates Technology
- Early Childhood Education and Computers
- Educational Telecommunications: Exploring Resources on the Internet
- Educational Telecommunications: Putting Students in Touch With the World
- Educational Telecommunications: How do I FTP a Little Bit?
- Effective Use of Classroom Networks
- Evaluating a Technology-Supported Lesson Plan
- Exploring the MECC Software Collection
- Find It: A Guide to Electronic Information Resources for Teachers
- Games and Puzzles in the Classroom
- Gradebooks and Student Record Programs
- Hypermedia as a Student Tool in Social Studies
- Instructional Applications of Graphing Software/Equation Solver Programs
- Integrated Learning Systems: What Are They and How Do We Use Them?
- Interactive Video in the Classroom
- Introduction to Hypermedia in the Classroom
- Locating and Evaluating Technology-Supported Lesson Plans
- LOGO Programming Activities in the Elementary Classroom
- Microteaching Activities: Practicing Technology Integration
- Microworlds: What are They and What are They Doing in My Classroom?
- Non-linear Information Sources and Their Roles in Education
- Student Centered Activities in the Computer Lab
- Student Developed Hypermedia Compositions: A Guide for the Teacher
- Student Produced Desktop Publishing/CD-ROM Projects

- Teacher Centered Activities in the Computer Lab
- The Computer in Physical Education
- The Computer in the Music Fundamentals Class (or Art, Art Appreciation)
- The New NCTM Guidelines and the Role of Technology
- Using Content (or Process, Problem Solving, etc.) Simulations in the Classroom
- Using ERIC on CD-ROM to Search the Professional Literature
- Using Laserdisc Packages in the Sciences
- Using Simulations in Geography (or Physical Science, Biological Science, Business Ed.)
- Using Technology in Reading (or Language Arts, Journalism, Writing
- Whole Language Instruction and Technology
- Writing Centers and Computers

There are many, many more possibilities, but the list is a beginning. I also hope the list stimulates your interest in developing a few modules of your own.

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ISSUES

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"The more things change, the more they remain the same" - Alphonse Karr (1849)

As we begin our examination of issues facing education in the early 1990s, it may be useful to examine the words of a commentator of mid 1960s urban America. In an examination of the urban maladies of the time, Mitchell Gordon (1965) devotes a chapter of his book to education, stating in part:

> "Beyond their original objectives of instilling the five "R's"—reading, 'riting, 'rithmetic, the ability to reason, and a sense of responsibility—the nation's public schools are expected today to combat all manner of handicap, mental as well as physical, social as well as economic. In addition, they are being called upon to raise educational levels to meet new challenges of scientific achievements in the race for space and nuclear supremacy, to cope with the complex demands of world leadership, properly channel the use of lengthening leisure, and otherwise equip an amorphous electorate for a better understanding of complex political, economic, and sociological change.
>
> The raising of educators' sights necessitates special attention to the needs of the slow learner, the special capabilities of the gifted and, indeed, the custom-tailoring of education to the entire student body as a collection of individuals with varying capabilities in different subjects and at different ages. New subjects must be taught and old ones taught better. Abilities and achievement must be more precisely determined and guidance more painstakingly provided, moreover, if broadening alternatives are to be intelligently selected."(pp. 221-222)

The problems of contemporary education have a remarkable similarity to those that Gordon described over a generation ago. We continue to try to struggle to adapt mass education to the needs of disparate individuals. One tool that gets increasing attention as a catalyst for educational change is the personal computer, and associated high technology equipment. But as Tom Puk explains in our first selection, the term "technology" has come to have decidedly different connotations. He develops a definition of the term incorporating physical, human and environmental components, and proceeds to build a case for their inclusion into preservice and inservice curricula.

Cleborne Maddux, Lamont Johnson, and Steve Harlow follow with an insightful analysis of the problems of the young discipline of computer education. While noting that computers are "here to stay", they are pessimistic about the prospects for integrated learning systems becoming a cure for educational ills. They note that much of the rhetoric prevalent on the political scene today represents simplistic answers to complex problems, and as such, are doomed to failure.

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If computers are to play a major role in solving the problems of education, Rosemary Skeele makes a persuasive argument for the inclusion of social and ethical issues of computing in our curricula. Her paper offers concrete suggestions for incorporating ethical issues into the curricula at all grade levels, and offers suggestions for the development of a code of ethics. Yet, even with the best of intentions, technology may fail to have an important impact in educational outcomes. Ron Zambo laments that the current level of computer integration is paltry, and proceeds to examine obstacles to incorporation into the mathematics curriculum, though his analysis is probably appropriate for other disciplines as well.

The second group of papers is centered around educational restructuring through technology. Hersholt Waxman begins by identifying the potential and limitations of integrating technology into schools in an attempt to reduce the risk of failure for urban students. Mark Whitman follows with a discussion of the trials and tribulations of establishing a professional development plan to assist educators in incorporating technology into the classroom. Finally, Neal Strudler focuses upon the changes in teacher preparation that will be required as a consequence of both restructuring and technology, and also serves as an introduction to the next group of papers.

The third group focuses upon the need to train teachers to understand and make appropriate use of technology. Robert Hess leads off describing what he terms an "infused" model of computer and technology education for preservice education. Keith Wetzel notes in his paper that while the overwhelming majority of schools of education report that their graduates are offered some computer training, two-thirds of the graduates of those schools report that they are unprepared to use computers in teaching. His paper addresses what competencies are required and how they might be achieved in preservice education. Next, Frederick Smith examines how technological change is "managed" in school organizations, how it is implemented in teacher education, how resistance to change is overcome, and how to transfer the technological skills from the preservice course to the school classroom. Morris Beers, Mary Jo Orzech and Anne Parsons follow with a description of incorporation of computing into the preservice curriculum at SUNY-Brockport. Finally, InÇs Chisholm examines the particular role that technology will play in bilingual and multicultural education, and the need to emphasize technology in training in these disciplines.

The last group of papers describes noteworthy projects that address significant educational issues. Audrey Keyes chronicles a project at Milwaukee Area Technical College designed to integrate technology into the technical education curricula, noting that fewer than half of the high school graduates go on to college, and still fewer graduate from college. Accordingly, technical curricula are vitally important to prepare the "neglected majority" for the high technology workforce. Eric Smith, Guy Westhoff, Gayle Munson and D. John Redman follow with an examination of the Taliesin Project at the University of Northern Colorado designed to marry traditional approaches to mathematics, science and technology with hypermedia tools. Next, Marlin Thomas describes a project using a local area network to encourage undergraduate composition students to examine their own writing by facilitating the creation of "writing communities." Finally, Deborah Bauder, David Carr, Mary Planow and Ronald Sarner analyze changes in teachers' attitudes towards computing as a result of their participation in an extensive, federally funded, inservice development project.

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Technology, Technology Education, and Teacher Education: A Rose By Any Other Name?

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Abstract

The word "technology" is used by different groups to mean different things. However, there is a commonality among all usages of the word and this must be reclaimed to empower the learner in making meaning of a world that is not as cryptic as we have allowed it to appear. Technology is currently being described as "knowledge-based knowhow". Under the umbrella of ***Technology Education***, both high-tech and low-tech forms of technology are explored in all disciplines through three curriculum foci: i) human processes, ii) physical products, and iii) environmental ecosystems. Each of these foci are in turn examined using a set of generic central technology concepts of structures, structural arrangement, materials, fabrication, mechanisms, energy and power, control, systems and the aesthetic. Based on the posulate that the nature of teacher education will change in that instruction will require a more interdisciplinary approach to subject-matter, a growth sequence for preservice and inservice training is provided.

Traditional Assumptions

We can use the word "technology" to create many diverse images. In some educational contexts, the term has come to be associated with physical products used in communications such as the computer. In the workplace, the more traditional understanding has seen technology being equated with industrial processes. However, it is the position of this paper that there is a much more important point to be made of all this; i.e., that the term technology has a much more comprehensive role to play in education.

In both of the more common ways we use the term technology (i.e., as educational technology or as industrial processes), the assumption is that defining the term is unnecessary because we all know what it means. In the case of technology as computers, the assumption is that technology is any kind of machine that can be used to augment the teaching/learning process. Thus, other forms of technology such as computer-linked projection panels and laser discs are considered to be in the same category. In industrial processes, machines or tools such as the CAD/CAM system or robotics are considered to be forms of technology.

Some serious limitations exit to our usage of this term in education. These limitations have important implications for teacher education.

Problems With Our Traditional Assumptions

By assuming that technology is either computers or other kinds of complex machines, we are teaching people that technology is "high-tech" and that all "high-tech" development must be good. There are several limitations to this assumption:

i) The narrow focus on the usage of high-tech leaves the user dependent upon the technologically elite to decide what is valuable. Leaving the responsibility for the development of technology to an elite few encourages dependency by the majority.

ii) High-tech products are seen to be complex machines that are beyond the understanding of most citizens. If our understanding of technology remains cloudy due to its perceived complexity, it may cause citizens to shrug their shoulders and leave it to others to solve their every day problems. This technological dependency due to the perceived inexplicable nature of technology is insidious in that there is an unseen transference to other contexts.

iii) Although the development of "high-tech" may have improved the material world of some, this has not necessarily translated into a corresponding growth in personal happiness and contentment (i.e., the self-actualized person"), in that group of people nor, more importantly, in the majority of citizens.

iv) Too often technology has been responsible for the creation of inhospitable environments. Our uncritical willingness to accept complex machines as being our personal saviours has in the past led to the development of high-tech machines simply because we are capable of producing them without a corresponding responsibility to the environment.

Expanding Our Definition

To say that a computer is a technology does not really define technology. A computer is only one example of a technology. Thus, we must ask ourselves what computers, lasers, and robotics have in common that makes them all forms of technology. Currently, the term technology is being more generically equated to "knowledge-based know how." Boulding has described technology as "ways of doing things" (Franklin, 1991, p.15). Franklin has described technology as being "both the structure and the act of structuring" (p.14). The author has defined technology as being a "systematic method of achieving a practical purpose" (Puk, 1991, p.1). A computer is both a structure and used in the act of structuring products. It is systematic in that it contains mechanisms that follow a set of rules that are repeated over and over again. We can now use this more comprehensive meaning of technology to understand the similarities among computers, lasers, and robotics.

Technology Education: The Curriculum Emphases of Human Processes, Physical Products and Environmental Ecosystems

No doubt the more comprehensive meaning of the term technology will be understandable to most in terms of physical products. However, human processes such as designing, voting, and group learning procedures also can be analyzed with our definition. Any formal procedure has a set of systematic rules or steps to follow and is used to accomplish specific tasks. Processes and products are also used to create and change environmental ecosystems (for example, the liming of lakes to neutralize acid rain). These are all forms of technology.

Curriculum Emphases	Central Concepts
	Structures
Human Processes	Structural Arrangement
	Materials
Physical Products	Fabrication
	Mechanisms
Environmental Ecosystems	Energy and Power
	Control Systems
	The Aesthetic

Figure 1. Taxonomy of Technology Curriculum Concepts

Generic Knowledge Concepts and Their Role in Teacher Education

Much work has occurred over the past decade in identifying and developing generic or interdisciplinary skills; that is, skills that are not specific to a subject-matter or context. Although not as much has been said about generic knowledge concepts, the author has previously suggested some direction in applying the same notion of transferability of skills to the transferability of knowledge structures (Puk, 1990). Since that time, a set of generic, central technology concepts (Puk, 1991a, 1991b, 1991c) has been identified and is beginning to be used in practice.

Central Technology Concepts

If we were to reflect on what various technologies have in common, we would probably agree that each is an example of a *structure*, each has a *structural arrangement*, each is *fabricated* (made, constructed, manufactured, etc.,) using various kinds of *materials*, each is composed of *mechanisms* that allow the larger structure to work, each has a source of *power* and type of *energy*, each has its form of *control*, each is part of a larger *system* (or is made of smaller systems) and each has its *aesthetic qualities*. The Taxonomy of Technology Curriculum Concepts (Puk, 1991b,1991c) found in figure 1 is a result of combining these central concepts with the curriculum emphases.

Students must be taught to use these concepts and curriculum emphases in all disciplines in order to identify the commonalities between diverse kinds of technologies. They then must be taught the mechanisms (i.e., the teaching/learning procedures) that empower them to further explore these technologies using "meta-explorations" (Puk, 1991c). In particular, students must be taught how to develop conceptual models that allow them to understand what is occurring within a complex technology.

"Often it is the structural arrangement of the physical product or human process which creates this unfathomable nature of technology. A learner can not observe the inner workings of a computer because the computer has an external "skin" that prevents observation. [However, even if we go beyond the casing of the computer, for example, there are no moving, perceptual parts]. Much of what does occur in the internal workings of a high-tech machine does so at the level of the atom or even at the sub-atomic level". (Puk, 1991d, p.31)

The only way to make the invisible visible in complex technologies is through the conceptual world.

Preservice Training and Inservice Workshops

The inclusion of ***Technology Education*** into Teacher Education will require a restructuring of mind-sets. ***Technology Education*** will be for all teachers in all disciplines. Thus, specific strategies must be used to bring about this integration and acceptance. Unfortunately, teacher education as conducted through universities to this point has chosen to emphasize the differences between disciplines rather than their similarities.

The following growth sequence for integrating the taxonomy into teacher education would occur through a series of sessions. However, the first thing that will be required to implement this growth sequence is for those involved to value preservice training and inservice workshops as an opportunity to gather together teachers and would-be teachers representing various disciplines.

i) The first session should involve a discussion about the definition of technology, the past assumptions about technology, the limitations inherent in these assumptions, and the implications of a more comprehensive understanding of technology to teacher education. The group should attempt to get at the essence of what technologies as physical products really are (i.e., what makes a computer a technology).

ii) Once the nature of the comprehensive definition of technology has been explored in regard to physical products, the conversation should be expanded to include human processes and environmental ecosystems. Teachers should attempt to identify examples of technologies that fit the definition as they apply to these other two curriculum emphases.

iii) Once the more comprehensive definition is understood as it applies to all three curriculum emphases, teachers should then be shown one example of a technology that is a physical product and asked to describe what it does, how it is made, what it is made of, what powers it, what controls are involved, and what is appealing about it. In this way, teachers are beginning to identify specific examples of central concepts without yet realizing that these specific examples also have a generic application.

iv) Examples of various kinds of physical technologies can then be presented in order to make comparisons with the first example. The same set of initial questions would be utilized. The next question would be, "What do these products have in common?" At this point a comparison matrix could be used to identify the commonalities. In most instances, teachers will identify labels specific to a technology rather than the central concept name. At that point, the question becomes, "Is there a generic term we could use to describe these different labels?" At this point, the more formal set of central concepts should be identified.

v/ Once the group has become comfortable with the central concepts as they apply to physical products, the group should proceed to apply the central concepts to human processes and environmental ecosystems.

vi/ The group might then become more systematic in its analysis of central concepts and curriculum emphases as they apply to discipline-specific subject-matter.

Once these central concepts have become internalized, teachers would then reflect on how these knowledge objectives (i.e., acquiring knowledge about central concepts) can be integrated with learning skills objectives. A more indepth explanation of how this would work is found in Puk (1991).

Teachers of Technology in Teacher Education

If the growth sequence described above were to be put into practice, it would change the nature of teacher education in that Technology Education by definition is not an isolated discipline. There is a technology inherent in any subject matter. Instructors at colleges of education will require the expertise to visualize the generic knowledge and skills patterns found in any subject matter. These people might be utilized to complement existing discipline-specific courses by working within those courses or as instructors of interdisciplinary-focused courses. In the former example, the focus would be on discipline specific subject matter augmented by generic technology concepts and learning skills while in the former the emphasis would be on generic technology concepts and learning skills brought to bear on each teacher or student teacher's specialization.

Conclusions

The discussion began with reference to what has become a cultural problem: the unexamined assumptions involved in the usage of concepts. The term technology has become somewhat of an empty vessel to which individual agendas bring specific images. Although some might say that this is necessary for individual expression, unfortunately it is a confusing phenomenon that shackles the new learner to dependency on others.

The concept of "technology" has a much more comprehensive, utilitarian role to play in education than has traditionally been the case. The generic definition of a technology being a systematic method of achieving a practical purpose serves to empower the individual in making meaning in what must appear to be a world of disconnected parts. The notion of a generic set of central concepts that can be used to understand technology as it is found in physical products, human processes and environmental ecosystems is appealing in that it provides a mechanism to derive meaning in diverse forms of technology.

There should be an interdisciplinary emphasis placed on technology education in teacher education and this restructuring will have an impact on the expertise required from those who teach teachers.

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The State of the Art in Computer Education

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Abstract

The authors discuss a number of pressing issues confronting the field of educational computing, and call for ongoing debate of these problems. Issues discussed include lack of organizational consensus, lack of theoretical and practical consensus, the role of technology in school reform, the proper role of integrated learning systems, and the proper role and time for computer integration.

Although computer education is a young discipline, there has never been a shortage of issues and controversies. That is as true today as it was more than a decade ago, when educators first began to sense the revolutionary educational potential offered by the wide availability of small, inexpensive, personal computers.

Today, assessing the state of the art in this exciting new field can make one feel a little like a character in a "good news, bad news" joke. The good news is that computers have found their way into classrooms across the country, and they are here to stay. They have become so deeply ingrained in mainstream culture that a place in the subculture of schooling is assured. As a matter of fact, we probably couldn't prevent the entry of computers into schools even if we were so inclined.

The bad news is that the entire process of bringing students and computers together in schools is being carried out in ways that are often inefficient, poorly planned, and incredibly chaotic. Perhaps that is understandable, given the inefficient, poorly planned, and chaotic nature of educational funding, regulation, and administration in this country. Although these conditions are primarily external ones and they cannot be significantly improved from within the ranks of computer education, there is nevertheless room for considerable improvement in areas we do control. This paper will present some of the issues that are crucial to the success of our efforts to integrate technology and schooling. Perhaps such a discussion will serve to help identify our options, focus our professional efforts, and stimulate wider discussions that may lead to creative solutions of our considerable problems.

Lack of Organizational Consensus

The field lacks continuity in the formal organizational structures underlying the computer education movement in the schools. Some school districts employ a district computer coordinator, but many do not. Even among those districts that do employ coordinators, duties and powers vary tremendously. Smith (1991) makes reference to this diversity and suggests that coordinators should be, but seldom currently are, true administrators, since they are seldom decision makers. Instead, most coordinators are placed in the role of advisors to other administrators who then make the actual decisions about curriculum and technology.

Many districts have no one person designated as a leader in educational computing or technology. In such districts, powers and responsibilities are diffused and reside in various roles such as principal, curriculum coordinator, math or science coordinator, etc. Although individuals in such roles are becoming somewhat more knowledgeable about the potential of technology, they remain relatively naive.

This trend has not escaped the notice of those firms who sell hardware and software to schools, and has played a role in the proliferation of large, expensive, self-contained integrated learning systems (ILSs). These systems are often chosen by technology naive administrators who welcome the idea of turning over difficult technology decisions to a single vendor who they believe (usually erroneously) are more knowledgeable than they are about educational computing. This issue will be discussed later in this article.

There are several problems with diffused power and responsibility. One problem is that administrators often look at their newly acquired responsibility as ancillary and subordinate to their other, primary duties and responsibilities. Such an attitude is not conducive to professionalism in educational computing, nor to excellent, related decision-making.

Another problem is more basic. The lack of a professional niche for expertise in educational technology sends a message to the profession that such expertise is not highly valued.

A third problem is that educators who wish to make technology their primary concern and primary responsibility do not know what role they should prepare for. They do not know what degree or what credential to pursue, and no particular degree or credential is a guarantee of professional qualification in other school districts. Every profession requires a set of qualifications that are similar across the nation, and identical within a given state. Without consensus on such matters, we can never hope to establish decision-making about educational technology as a professional role on a par with others such as principals.

Lack of Theoretical and Practical Consensus

The field lacks consensus about why technology should be integrated with schooling, and on how it should be used if it is integrated. Because we lack consensus in these matters, we cannot agree even on very broad goals and objectives.

There is controversy in all educational subspecialties, and such controversy is generally healthy. Nevertheless, reading specialists, for example, can agree on the need to improve reading skills of students. Some may prefer approaches such as whole language, while others may prefer a more skills-oriented approach, but all of the diverse theories and approaches in reading are aimed at improving the ability to comprehend the written word. In educational computing, we do not have such broad consensus even about general goals.

This organization (The Society for Technology and Teacher Education) and others should consider forming committees and task forces charged with seeking consensus about a host of theoretical and practical concerns. Perhaps it is still too early in the development of the field to hope to find such agreement. However, our professional development may have progressed as far as it can until we begin to identify some common goals and beliefs, and until we begin to work in an organized fashion toward achieving those goals.

The Role of Technology in School Reform

"School Reform" is the hot topic of the year. As most of us know, the current obsession with reform grew out of the many critical reports issued by a variety of committees and commissions convened in the 1980s. Most recently, the U.S. Department of Education has issued America 2000, a so-called "Education Strategy." This 80-page pamphlet is both a blatantly political and a childishly ingenuous document that is, nevertheless, (or perhaps consequently) showing signs of achieving a ubiquity similar to that enjoyed by Chairman Mao's "Little Red Book" in post Cultural Revolution China.

There is something quixotic about the idea that Fortune 500 CEO's, together with federal, state, and local politicians can correct the ills of American public education. Perhaps they can, but the idea might be taken a bit more seriously if business and the Federal government had a slightly better record of their own over the past few years. After all, Japanese business interests continue to prosper while our own economy teeters precariously on the brink of recession, the magnitude of the savings and loan debacle becomes daily more apparent, bank failures continue to increase, the airline industry is in disarray, the automotive industry seems in trouble once again, New York City struggles to avoid bankruptcy, and public confidence in politics and politicians is at an all-time low.

For these and other reasons, America 2000 is both an affront and an opportunity. It is an affront in its implication that all would be well with America's schools had educators only set goals such as those found in America 2000. President Bush, Lamar Alexander (Secretary of Education), and the other architects of the little red book seem to believe they have invented goals such as drug-free and violence-free schools, and the idea of experimental schools. In addition, the document reflects no understanding of the fact that schools are a microcosm of the society in which they reside, or that setting goals is infinitely simpler than achieving them.

Nevertheless, there may be some opportunities for those educators who have a high tolerance for political posturing and condescension. Nearly every commission report of the last decade has suggested that computers are a necessary component of reformed schools. We should take advantage of this enthusiasm for technology.

There is a danger in all of this, as well as an opportunity. The goals of America 2000 are not attainable. They are simply unrealistic in their scope and time table. For example, in the year 2000, every school in America will not be drug and violence free, and every adult American will not be literate and ready "to compete in a global economy and exercise the rights and responsibilities of citizenship."

These things will not come to pass by the year 2000. It is symptomatic of the extent of the task before us that our national capitol is itself one of the most drug-plagued and violent cities in the world. The little red book suggests that we have eight years to rid schools of drugs and violence, even though the neighborhoods, the cities, and the nation in which these schools are located are increasingly pervaded by drugs and violence! To reach the goal of literacy, schools have only slightly more than eight years to impart literacy, not only to every public school student, (an impossible task in its own right) but to every adult in the country!

Robert Browning said "Ah, but a man's reach should exceed his grasp, or what's a heaven for?" A physician friend modifies the question in this quotation to ". . . or what's an ulcer for?" The question for computer educators is what will be the long term effect of setting unrealistic goals? In educational computing, we have been guilty of overly optimistic claims, and the result has been a backlash of public opinion against educational computing.

It is always dangerous to promise more than can be delivered. The danger is that when school board members, lawmakers, and other policy makers realize that their expectations have not been met, they may "throw the baby out with the bath water."

Although we have stated that computers are now an irresistible force in schools, a major reform failure that relies heavily on computing could seriously impede and delay their educational implementation. It is essential that we initiate discussion about how visible we want computing to be in efforts to reform schooling. Do we stand to lose more than can be gained when Education 2000 goals go unmet, and the inevitable search for a scapegoat ensues? This organization and others would do well to address these and other reform questions in pursuit of a coherent, well-planned, and united front. Like computers, Education 2000 is not going to go away. How should we respond?

The Proper Role of Integrated Learning Systems

Many schools have elected to purchase an integrated learning system (ILS) as their response to the computer education initiative. These systems are local area networks with an installed base of instructional software and an integrated management system. Such systems are often expensive, costing tens of thousands of dollars, and the companies that supply them provide the hardware, installation, inservice training, and maintenance. Integrated Learning Systems seem to have their greatest appeal with noncomputer-literate, higher-level district administrators who are attracted to the idea of turning all technology-related decisions and tasks over to noneducators.

Although such systems do have certain advantages, they also have definite drawbacks:

1. The use of an ILS restricts the pool of software available for use in the school. This occurs since the company that installs the ILS must arrange to acquire site licenses for all software placed on the system. Since not all software producers provide a site license option, and because negotiating for such licenses takes time, there will always be a large number of programs that are available for traditional purchase and use on individual machines that are not available for installation on the ILS. Then too, even if site licenses are readily available at reasonable cost, any software placed on the ILS must be integrated with the management system. This is also a time-consuming process.
2. Turning over technology decisions to noneducators sounds appealing to some administrators. However, to do so will inevitably result in turning over a number of important educational decisions to them, as well. This is particularly true concerning the details of the management system, since there are decisions to be made such as criteria for repetition of units, sequence of units, feedback, and branching decisions, for example.
3. Maintenance problems can be especially troublesome with integrated learning systems. Some ILS vendors have a tendency to blame educational software for system glitches, while software houses may take the position that they are not responsible for the performance of their software since it was not designed to run under the particular ILS management program. The net result can be unsatisfactory performance and an inability to determine who is responsible for correcting such problems.
   Hardware maintenance can also be troublesome. With stand-alone units, loss of one unit does not affect the others, while some ILS hardware problems can easily shut down the entire system.
4. Teacher training can be a problem. Although ILS implementation relieves educators of some difficult

technology-related decisions, system operation is much more complex than the sum of the complexity of operating a number of stand-alone computers. In addition, engineers and programmers employed by the ILS vendor are seldom skilled at training teachers, and may be insensitive and impatient with anyone who lacks technical expertise.

What is the Proper Role and Time for Computer Integration?

There is a great deal of discussion in our literature on the topic of integration of computers, and we have addressed this issue at length elsewhere (Maddux, 1991). Briefly, many authors suggest that we should make a choice between computer labs and integration of computers into regular classrooms. Our bias is that we do not regard this as an either/or issue? At the present time, it appears that there is a critical shortage of (a) excellent educational software, (b) school based computers and peripherals, and (c) expertise among regular educators. Until such shortages are corrected, calls for integration may be premature. In addition, we believe that there will probably always be a need for computer labs and educational computing specialists, even when and if computing is integrated into the entire curriculum. The fact that reading and writing are integrated into all subjects has not brought about an end to reading or writing specialists, or classes whose primary purpose is to improve reading and writing skills. This is another issue about which we believe it is important to encourage debate and pursue consensus.

This paper has presented only a few of the pressing problems and issues that confront us. We could also have mentioned issues such as computer programming and transferable problem solving skills, the state of the art in educational computing research, the proper role of Logo, expert systems and artificial intelligence in assessment, the state of the art in educational simulations, and a host of others. It has not been our intention to attempt to present solutions to these problems, although we obviously have our own opinions about what some solutions should include. Instead, we have endeavored to stimulate interest in debating the issues. After all, it is this debate that makes scholarship stimulating and productive. We believe that it is to the open discussion and debate of these and other issues that we should dedicate the Society for Technology and Teacher Education.

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The Social and Ethical Implications of Computers in the Curriculum

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Abstract

Society as a whole is just beginning to come to terms with major issues regarding computer ethics. Very few schools teach computer ethics. Schools should have in place an enforceable computer ethics policy to use as a base for teaching computer ethics, as well as some means of ensuring computer security.

Computer ethics should be embedded in the computer curriculum when students begin using computers. Teaching should begin with a definition of ethics that is understandable by all concerned. Case studies, analogies, discussions, role play, and research projects are all useful methods for teaching computer ethics. Teachers, administrators, parents and students must all be instructed and participate in the ethical use of computers if the program is to be effective and the ethical climate of the school established.

Society as a whole is just beginning to come to terms with major issues regarding computer ethics and computer crime. One of the most important questions involves the relationship between ethics and the abuse and commission of crime with computers.

In the future, the computer criminal or the unethical practitioner will have the power to affect vast numbers of people. Nuclear warheads, satellite transmissions, medical decisions, and space flight are a few of the critical operations controlled by computers (De Loughry, 1988). For this reason, ethical behavior may be of more value than technical and management capability when it comes to selecting people for critical positions (Spiro, 1983). How should we be preparing teachers for the future of computing?

Speaking to a group of religious leaders, Lauro F. Cavazos, U.S. Secretary of Education, stated that there was "... an enormous way to go to bring sound values education into the nation's public schools." He expressed concern that values education "... is a very, very difficult issue to get in front of educators" ("U.S. Education Secretary", 1990, p.20).

Why Teach Computer Ethics?

Few schools teach computer ethics. When teaching the technology takes so much time, why should ethics be included in the computer curriculum? My own situation was the cause for my research on this topic; each semester I teach a computer literacy course to undergraduates. Following an assignment on computer crime and security, I decided to include some discussion in class involving computer ethics. These are some of the comments made by my students:

1. "Anyone smart enough to spread a computer virus should be given an important job."

2. "Using your brain to get something isn't a crime."

3. "Pirating software isn't a crime. It doesn't matter if you steal from a powerful, rich corporation. They probably used unethical means to get their money anyway."

What happened to my usually conservative thinkers? Did I understand what they were saying? I had an entire class of Robin Hoods! Did their attitudes represent prevalent attitudes in society in general? How could I explain my feelings and the concept of ethics to them? What changes in the curriculum could I make to change their attitudes?

Through research, I discovered that my students' views about computer crime are not very different from those held by the general public. Computer crime is not considered serious crime. But why not?

Is it because the laws are not clear and lag so far behind technology (Holmes, 1984)? Laws concerning computer crime are usually enacted after crimes are discovered. Laws represent the needs and desires of citizens. Thus if an action is not illegal, it's perceived by the public as being acceptable behavior.

Could it be that we don't consider something done with a computer a crime? Are we still in awe of those who can capably use computers? Students who commit computer crimes are not the type who would steal the milk money or vandalize the school. Usually they are bright and trustworthy. School administrators have tended to ignore the problem because "no one got hurt" by students' actions. They were just improving their computer skills by trying to "beat the system."

Students believe that their intelligence requires them to overcome obstacles and find new challenges, even though these may include unethical or illegal actions. Such was the case of Robert Morris, a brilliant graduate student at Cornell who inserted a virus into the Department of Defense ARPANET computer network. Unfortunately, his program included an error which caused all the computers he penetrated to crash (Wines, 1988; Markoff, 1988). According to Spiro, "It is up to us to carry the message that theft is theft, and that it is, if anything, worse when the theft is done by an intelligent, gifted, and economically well advantaged individual" (Spiro, 1983, p.33).

Is it because of the complicated technology itself that committing a crime with a computer is not considered a crime (or as serious a crime) by some people? For example, according to Deborah Johnson (1984), ". . . it appears that some people, at least, do not think that intentionally gaining access to someone else's computer file is as serious a wrong as intentionally breaking into an office then into a file cabinet" (p. 64).

Breaking into a file cabinet would never be considered by the same person who would not hesitate to obtain private computer files. Why don't people think their actions are wrong when using a computer? Is it the distance between the transgressor and the victim that dilutes the seriousness of the crime? No one can see them. They cannot see whom they are hurting. It is unclear whether they can or will be punished for their actions. Since the technology is so new, there are few examples of people being caught and prosecuted.

The Computer Ethics Curriculum

An important concept to clarify when addressing ethical concerns in a computer curriculum is: what is a computer crime? It is very helpful to demonstrate an analogy between a clear-cut crime, such as robbery, and the novel, often murky case of using a computer to commit a crime. Analyzing the differences between stealing a car and stealing information clearly illustrates how analogies can be employed. The concept that information has real value like any other property is not understood by many people (Spiro, 1983). The analogy helps to identify and clarify unethical situations which may not be apparent when using a computer. It is also important to explain thoroughly the various consequences of computer crime, particularly if you can relate a consequence to the students.

In the Robert Morris case, my own students were not impressed by the fact that companies lost thousands of dollars trying to figure out what went wrong with their computers. Most felt that Morris performed a service by demonstrating a lack of security in the network. Then I told them that the Organ Transplant Association was part of this network, and cross-matching of donors was delayed for two days. They quickly began to change their minds about the seriousness of Mr. Morris's actions.

Defining Ethics

When developing a computer ethics curriculum, it is important to begin with a definition of ethics that is understandable by all concerned. The idea of discussing ethics probably sounds very vague and elusive if you are used to dealing with problems that have more definitive answers.

Ethics means different things to different people, making it a difficult thing to define. The following are useful, easy-to-remember definitions that don't intrude in anyone's civil liberties and are not specifically religious in nature. Ethics doesn't have to be associated with a preachy mentality. You will not be teaching religion in the public schools (Holmes, 1984).

"A very simple definition of something that is ethical is that which is innately right such as Thou shalt not kill" (Mizock, 1986, p. 16). Simpler still is that ethics is a code of conduct or set of principles to live and work by, usually based on the golden rule.

We can distinguish between morality and ethics. According to David Novick, "... morality is our knowledge of what is good, and ethics are systematic ways of resolving conflicts between competing goods." In other words ethics is a way of solving problems when there is a conflict of values. The value of curiosity is clearly at odds with the value of privacy in many situations" (1984).

Ethics means knowing right from wrong and then doing the right thing. Computer ethics cannot be different from personal ethics. It is a code of conduct which specifies a higher form of behavior than strict obedience to laws.

Why should we include ethics in the computer curriculum? The two largest groups who commit computer crimes are employees of financial institutions and government employees. The third largest group is students (Chin, 1983).

Thanks to personal computers and telephone access to corporate mainframes, democracy has come to computer crime. Today a secretary can embezzle a fortune, and an adolescent can change grades between classes (Bequai, 1983).

Seventy-five percent of computer phone fraud is commited by people under 25. In one year in New York City alone, over $70 million in phone and computer fraud occurs. Is computer crime really victimless? Phone company charges are passed on to the customers (Weintraub, 1986). Somebody is certainly getting hurt. Computer crime costs business over a billion dollars each year ("The Perfect Crime", 1985). Repeated calls for help are being made to educators by business leaders. It is believed by some that it is impossible to instill ethics in an adult ("Sleaze and the middle manager", 1988).

Donn Parker, a well known author in the field of computer security, believes computer ethics should be implemented in the educational system at the point "... where kids get their first dose of computer technology" (Cited in Mizock, 1986, p. 29). Although computers are wonders of modern technology, students must learn that they can be manipulated to cause great harm. There is also an increased awareness by data processing professionals that they must get involved with computer ethics education (Mizock, 1986). Many companies offer free speakers and consultants to assist schools with this effort. For example, each year AT&T spends large sums to conduct educational programs in schools on computer and phone crimes (Weintraub, 1986).

Developing a Code of Ethics

Once you have explained ethics, the next step is to develop a school policy or code of ethics for computing. A committee will be helpful, and please don't forget to include the students. Everyone must follow the policy—teachers, administrators, students and parents. A computer ethics curriculum will be of little value if students receive a different message from their teachers or their parents.

Getting compliance with a code can be difficult as well as costly to a school district. It is easy to rationalize software piracy. Schools may have the money to purchase one software package but not enough for all the students. And what about the gifted child who would like to do extra work at home, but can't afford the expensive software? Parents even offer illegal software to schools in an effort to save them money (Weintraub, 1986). Parents play a crucial role in the development of ethical behavior in their children. They must be active in computer education.

Some of the areas that should be covered in a computer ethics policy include specific guidelines about:

- computer and phone fraud
- illegal copying of software
- invasion of privacy
- theft of service
- plagiarism
- sending obscene messages, and
- destruction of property.

The North Allegheny, Pennsylvania School District has developed a more complete computer ethics policy. The philosophy behind their computer program was to prevent problems. They felt that students would be more honest in their computer behavior if they had clear guidelines and knew the consequences of their actions.

"Many schools and state departments of education have mandated that students be taught the ethical and social implications of computers and that they learn how to use computers in socially responsible ways" (Bear, 1986, p.115). In California, where schools have had computers for many years, only schools with a computer copyright policy may apply for grant money (Weintraub, 1986). Before graduating in Virginia, students must be able to "identify and evaluate major ethical, social and economic issues which relate to the use of computers" (Bear, 1986).

To be effective, a computer ethics policy should be accompanied by the following measures:

- Use clear methods to enforce the policy. A policy without teeth will be ignored. The only way to restrain students who don't have a personal code of ethics is to put a deterrent into the system. "It is important to treat computer crime as serious crime, not just 'boys and girls being boys and girls'" (Comer, 1985, p. 158).
- Develop a computer ethics curriculum, or at least integrate ethics into the current curriculum. Couger

(1984) reported that peer recognition for "beating the computing system" was the most common response given by students when questioned about reasons for unethical behavior involving computers. An environment of honesty must be established.

- Take measures to insure security. Lack of computer security is a universal problem faced by business and government agencies as well as schools. In 1990, a congressional hearing was held to disclose the inadequate security measures used by various branches of the federal government. An astronomer named Clifford Stoll testified at the hearing about how he stumbled upon electronic spies from Germany while trying to catch what he thought was a local hacker breaking into his organization's computer. His recent book "The Cuckoo's Egg" details the outrageous vulnerability of a number of supposedly secure government agencies (Orr, 1990). Software, equipment and data must be protected. Not having a security system sends a clear message to the students and leaves a school district open to legal action by software manufacturers if piracy is discovered. Our educational system has been named as a contributor to the problem of computer viruses because it has ignored security problems (Cohen, 1988).

All of these measures are designed to improve the ethical climate of the school. That is why it is important to prepare a policy that is specific about certain kinds of behavior, is enforcible, and carries some form of sanction for noncompliance. If your policy does not provide the basis for a student's good behavior, it may at least act as a deterrent to unethical conduct.

Teaching Computer Ethics

Developing a curriculum and implementing it are the next steps. Most computer textbooks, even the most popular, neglect the topic of computer ethics or social responsibility (Bear, 1986).

Some curriculum ideas workable at all grade levels for teaching computer ethics are:

1. Work with scenarios or case studies—use concrete examples of computer crime.
2. Report on articles or programs describing ethical issues (be alert for them in newspapers, magazines, and on television).
3. Allow no access to computers without discussion of ethical issues and legal responsibilities.
4. Use examples that encourage empathy. Children can better understand computer-caused discomfort and unfairness when they think about what would happen or how they would feel if they or the people they care about had been the victim (Comer, 1985).
5. Have students think about problems and propose standards and behaviors. Use role play (Heide and Hightower, 1983).
6. Have students write their own code of ethics.
7. Assign research projects on computer-related ethical or moral issues involving a variety of data collection procedures. Stress those methods that involve people's attitudes and opinions, such as surveys, questionnaires and field research (Bear, 1986).
8. Give hackers the responsibility for monitoring electronic snooping. Channel their technological knowledge to good purposes. It's been discovered that proficient computer users are more strict about policing misconduct than school administrators would be (Williams & Sandza, 1985).

The first curriculum idea—using case studies to promote discussion—is considered to be one of the most effective means for communicating ethical behavior. This activity provides just the right atmosphere for the school's philosophy on the subject to be emphasized.

Most computing teachers could provide excellent examples of computer misbehavior that could be used as case studies in teaching computer ethics. They help to explain clearly some of the unethical practices that are unique to computing.

When using case studies, don't give your opinion until the class discussion is completed. Try to draw responses from the students. Most important, don't be judgemental when they express their opinions, or you will find that they will either end the discussion or only repeat your ideas.

If developing case studies is too time consuming to add to your responsibilities, articles and books containing case studies are available.

Role of the Teacher

Ethics is often omitted from the computer curriculum because teachers have not learned how to teach the subject. Inservice education in the areas of moral education and social responsibility can be motivational. Preaching, lecturing and listing of rules are not methods that convey a sense of ethics or promote a rationale for doing what's right (Bear, 1986).

Teachers should be instructed in the ethical use of computers and encouraged to influence students when using the hardware—teachers are very effective models (Achter and Pelowski, 1986). They should never assign projects that convey to students that certain unethical practices are all right. Teachers should never give assignments that require students to beat the system, or use enticements such as copying programs or games to encourage new users.

"Computers are inherently apolitical, unbiased and unthinking machines, yet they may be used in ways which dehumanize and oppress people, or in ways which personalize and liberate people" (Taffee, 1984, p.15).

In "Questions for Teachers", Sharon Robinson (1982) states, "the role and influence of teachers in shaping the future of education in a technological society will depend on the ability of the teaching profession to anticipate, plan for and give direction to such change" (p. 29). As teachers it is our responsibility to dispel these fears through computer ethics education.

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Hindrances to the Integration of Computers with Mathematics Instruction

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Abstract

There is strong support for the integration of computers with mathematics instruction, but the level of integration is still low. Several factors are hindering integration. These factors include; hardware availability, software availability, the lack of training in computer use, the lack of training in integration, and the lack of time for planning and implementation. Although access to computers and training in their use has increased over time, teachers still lack appropriate models for successful computer integration.

Introduction

The National Council of Teachers of Mathematics (NCTM) (1989) strongly recommends the integration of computers with mathematics instruction at all levels K-12. Computers can, among other things, provide; a) an instructional platform for the introduction of new content, b) a powerful tool to free students from the grind of computing numbers and manipulating symbols, c) a connection between the concrete and the abstract through dynamic visual displays, and d) varied problem solving situations and applications.

Although the leadership in mathematics education strongly supports computer integration, the current level of integration is low. Friedman, Jurkat, and Pinkham (1991) estimated that the amount of computer integration with instruction stands, in one state wide system, at less than 1%. Now, more than two decades since the introduction of computers into classrooms, educators must continue to ask, "What are the hindrances preventing the integration of computers with mathematics instruction?"

Hindrances to computer integration have been investigated in several studies. The Appalachia Educational Laboratory (AEL) (1986) conducted a needs assessment for the integration of microcomputers with mathematics education over a four state area. The AEL concluded that three major areas of concern were:

1. Access to hardware and quality software designed for the teachers' needs.
2. Training in computer operations and the instructional use of computers.
3. Knowledge of methods for integrating computers with classroom activities.

Montgomery and Hunt (1991) surveyed teachers concerning the impediments to computer use in the classroom. The teachers' major concerns were:

1. The lack of computer equipment.
2. The lack of time to use it. Teachers also stated that they needed to know more about the integration of computers with the curriculum.

Thomas, Thompson, and Gilbert (1984) reported similar findings. Reported hindrances were:

1. The lack of computers.
2. The lack of software.
3. The lack of skills to integrate computers with instruction.

These five areas of concern; the lack of hardware, the lack of software, the lack of computer skills, the lack of knowledge about integration, and the lack of time, will be addressed individually in this paper.

Lack of Hardware

Insufficient access to computer hardware is an obvious hindrance to computer integration. There is no doubt that levels of access vary between states, school systems, schools, and grade levels, but in general computers are becoming more accessible over time. The Office of Technology Assessment (1988) reported that 95% of schools had computers with an average of one computer for every 30.8 students. In 1981 only 18% of schools were estimated to have computers with one computer for every 92.3 students. Indications are that access to computers will continue to increase.

Lack of Software

Lack of quality software is also a hindrance to computer integration. Although a large amount of educational software is available, questions remain about its quality and usefulness. General characteristics of the available software can be inferred from data about software use in classrooms. Dickey and Kherlopian (1987) reported that 83% of the teachers surveyed used drill and practice software to reinforce previously taught skills and 59% used game software as a classroom reward. Cardelle-Elawar and Zambo (1991) found that teachers who reported computer use in their classrooms used the computers almost exclusively for drill and practice.

Based on these findings, it could be inferred that the software typically available to teachers is either of the drill and practice or the game variety. This inference is partially congruent to Willoughby's (1990) statement that more than 90% of instructional software is designed to train the user in some specific low level skill. An overabundance of this type of software presents a major hindrance to integration in two ways.

First, the NCTM (1989) sets problem solving as the central goal of mathematics instruction and emphasizes the importance of understanding the underlying concepts of mathematics. A focus on drill and practice, whether computer delivered or not, is contradictory to the current vision of mathematics education. Even if the software is "quality" in its own right, the overwhelming emphasis on lower level skills is inappropriate for quality mathematics instruction.

This preponderance of drill and practice software possibly results from the old view of mathematics. Past mathematics instruction was dominated by the development of computational skills ranging from long division to integration. To facilitate integration, software which utilizes the power of the computer as an instructional tool and which aligns with the current trends in mathematics education must be identified and made available to teachers.

Second, although the predominance of software focused at low level skills does not preclude the existence of high quality software focused on concept development and higher level thinking skills, it does increase the difficulty of identifying appropriate software. The lack of time to identify, preview, acquire, and incorporate software into the curriculum prevents teachers from effectively integrating computers into instruction (Friedman et al., 1991; Montgomery & Hunt, 1991).

Lack of Training in Computer Operations

Lack of training in computer operations is another hindrance to computer integration. Computer literacy is prerequisite to computer integration. As computer availability increases, states are mandating that teachers be computer literate. In response to changing teacher certification requirements, an increasing number of teacher colleges are offering instructional technology courses which focus on the use and uses of computers.

Inservice teachers must also be provided with computer training. Unfortunately, there appear to be few training opportunities for inservice teachers. Dickey and Kherlopian (1987) found that 60% of the teachers interviewed reported having no training at all in computer use and only 10% had received any formal training. This may explain why 30% of the teachers surveyed in the same study had access to computers but did not use them. Kloosterman and Harty (1987) report that mathematics teachers on the average attended less than two hours of computer training per school year.

Training in computer use is doubly important because it indirectly encourages integration on the affective level. Beall (1984) suggested that past experience with computers increases teachers' "proneness to implement" computers in the classroom. Other research (Hunt & Bohlin, 1991; Bassler, Almeida, & Van Vorst, 1984) supports the notion that previous experience with computers correlates with positive attitudes toward computer use. Chaplin and Turkel (1986) found that a positive attitude about computers correlates with increased computer use and integration. Instructional computing courses not only provide the minimum skills of computer use but can also promote positive attitudes toward computer integration.

Lack of Knowledge for Integrating Computers with Classroom Instruction

The greatest hindrance to the integration of computers with mathematics instruction may be the lack of training specifically focused on computer integration. Access to hardware, software, and the skills to use them are prerequisite to, but not sufficient for, integration. Lacking the knowledge to integrate computers with instruction, teachers use available computers in an "add-on" capacity to reinforce previously taught skills.

Logically, integration skills should be developed during pre-service training. Unfortunately, many students only learn about computers in required computer literacy courses. Computer literacy courses generally treat computers as the object of instruction and not as an instructional tool. Education students rarely, if ever, see computer integration modeled in either their content area methods classes or in other classes (McNeil, 1989). If teacher educators do not provide a model of computer integration for their students, it is difficult for new teachers to conceptualize computer integration with instruction.

Lack of Time

Lack of time is a double-edged hindrance to computer education. First, lacking the necessary training in computer integration, teachers must rely on themselves to plan and implement integrated instruction. Researchers (Friedman, Jurkhart, & Pinkham, 1991) have found that if teachers are given adequate time to plan they can and will develop the expertise required to integrate computers into instruction on their own. However, this self-instruction places increased demands on teachers' already limited planning time.

Second, mathematics teachers report that there is insufficient time to adequately cover the currently required mathematics content (Cardelle-Elawar & Zambo, 1991). That perception, coupled with the view that computers are an "add-on" activity, discourages teachers from attempting to integrate computers with their instruction. Teachers must discover that computers are to be an integral part of mathematics instruction and a tool for doing mathematics, not an "add-on" activity which requires additional instructional time.

Summary

Although the access to hardware and software is still a hindrance to computer integration with mathematics, the level of access is increasing. The availability of computer literacy courses is also increasing at the pre-service level. However, supplying adequate equipment to teachers and training them in computer operations is insufficient for the integration of computers with mathematics instruction. Mathematics teachers need to develop skills in methods of computer integration. These skills could be developed either by the inclusion of computer integration models into content area methods courses; or by providing teachers with the release time necessary to develop plans for integrating computers with instruction on their own.

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Restructuring Urban Schools With Technology: Implications for Students At Risk of Failure

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Abstract

In the current school restructuring movement, integrating technology into schools is generally not considered an important nor critical activity. This paper discusses some of the potential as well as limitations of integrating technology into urban schools, with a specific focus on improving the education of students at risk of failure.

During the past few years, there has been increased recognition of the need to radically alter or restructure schools so that we can achieve our educational goals (U.S. Department of Education, 1991a). School restructuring generally refers to the redesign or reorganization of schooling at either the state, district, school, and/or classroom level (Polin, 1991). Rockman (1991) defines school restructuring as "an array of changes in curriculm and instruction, in school governance and accountability, and in the roles of teachers and administrators that, together, are meant to improve student learning (p. 26)." Conley (1991) defines restructuring as "activities that change fundamental assumptions, practices, and relationships, both within the organization and between the organization and the outside work in ways that lead to improved student learning outcomes (p. 15)." In addition to changing the current structure of school, educators and policymakers are also calling for changing conceptions or models of teaching and learning that emphasize more active student learning (Sheingold, 1990) and changing the role of teachers from a deliverer of knowledge to one of a facilitor of learning (Wiburg, 1991a)

Several specific ideas or activities have often been suggested as important to implement in order to effectively restructure schools. These include: (a) shared decision making and site-based management (Conley, 1991; Finn, 1991; Glickman, 1991; Polin, 1991; Smey-Richman, 1991), (b) school choice (Bell & Elmquist, 1991; Conley, 1991; Howe, 1991; Kearns & Doyle, 1989; Polin, 1991; Rigden, 1990; Sewall, 1991; Smey-Richman, 1991), (c) curriculum restructuring (Bell & Elmquist, 1991; Conley, 1991; Sewall, 1991; Smey-Richman, 1991), (d) creating national standards and tests (Bell & Elmquist, 1991; Finn, 1991; Howe, 1991; Kearns & Doyle, 1989; Sewall, 1991), and (e) enhancing school-community relationships and parental involvement (Bell & Elmquist, 1991; Conley, 1991; Smey-Richman, 1991). These ideas or activities that are most often associated with restructuring are not new, but it is the holistic approach of combining all of these together that hold promise for changing and improving schools (Rockman, 1991).

Students At Risk of Failure

In recent years, the number of students who could be considered at risk of school failure or "educationally disadvantaged" has increased and their degree of "disadvantage" has also increased (Levin, 1989; Pallas, Natriello, & McDill, 1989). In the 1988 National Education Longitudinal Study (Hafner, Ingels, Schneider, & Stevenson, 1990), for example, about 41% of black eighth graders and 37% of Hispanic eighth graders were characterized as having two or more risk factors (e.g., from single parent homes, having a sibling who dropped out of school, or home alone after school three or more hours a day). In their national study of "typical" elementary, middle, and high school students, Frymier and Gansneder (1989) found that nearly one-third of the students in their study were identified as having six or more at-risk factors (out of a possible 45 factors that they identified from prior research). Furthermore, the Carnegie Council on Adolescent Development (1989) estimated that about 25% of 10 to 17 year olds may be extremely vulnerable to multiple high-risk behaviors (e.g., school failure and substance abuse) and another 25% may be at moderate risk. These findings and other indicators like: (a) the high dropout rates for Hispanics, Blacks, and students in central cities (Kaufman & Frase, 1990), (b) the large number of students who live in poverty (La Rosa & Maw, 1990; Reed & Sautter, 1990), (c) the failure of students to do well on higher-level applications, complex reasoning, and problem solving (Mullis, Owen, & Phillips, 1990) illustrate the critical status of students who are currently at risk of failure in our nation's schools.

Another major concern is that the highest percentage of these students at risk of failure are found in inner-city, urban schools (Hodgkinson, 1991). Large, urban school districts face special challenges caused by factors like poverty and crime that make the solution to their educational problems very complex (Walberg, Bakalis, Bast, & Baer, 1988). Addressing the problems of inner-city schools is one of the most important national educational issues (Cuban, 1989). Nowhere are the social implications of increasing numbers of disadvantaged families in inner cities more prevalent than in the large, urban school districts where the deletorious conditions of underachievement, student and teacher alienation, and high drop-out rates exist. Furthermore, many of the physical structures and facilities in inner-city schools are abysmal and in desperate need of rehabilitation (Piccigallo, 1989). Those students attending inner-city or ghetto schools represent the most imperiled group of our increasing numbers of students at risk of failure (Boyd, 1991).

Restructuring Urban Schools Through Technology

Although technology is not often mentioned as a restructuring strategy, several educators maintain that technology can be the catalyst for restructuring schools (Bell & Elmquist, 1991; Sheingold, 1990). They argue that technology can enhance and supplement traditional classroom instruction as well as offer a new way to deliver instruction (NEA, 1989; Office of Technology Assessment, 1988; Olsen, 1990; Polin, 1991; Rockman, 1991). Some of the specific benefical roles of technology that they discuss include: (a) fostering students' problem solving and higher-level thinking (Dede, 1989; Held, Newsom, & Peiffer, 1991; Lieberman & Linn, 1991; Office of Technology Assessment, 1988; Olsen, 1990), (b) enhancing student-directed learning and autonomous learners (Bell & Elmquist, 1991; Held, Newsom, & Peiffer, 1991; Hornbeck, 1991; Lieberman & Linn, 1991), and becoming an effective management tool for teachers and principals (Bell & Elmquist, 1991; Braun, 1990; Hornbeck, 1991; NEA, 1989; Office of Technology Assessment, 1988; Polin, 1991).

Some approaches for restructuring with technology call for placing computers in every classroom. Others, however, argue against integrating computers into individual classrooms because computer expertise, hardware, and software are too scarce to decentralize resources (Johnson & Maddux, 1991). There is very little research, however, that supports either the use of separate computer labs or the integration of computers in each classroom. Furthermore, the research literature suggests that there is no single best use of technology in schools (Office of Technology Assessment, 1988). There is, for example, research evidence that suggests computer-assisted instruction (CAI) is beneficial for low-achieving students (Niemiec & Walberg, 1987; Office of Technology Assessment, 1988; Swan, Guerrero, Mitrani, & Schoener, 1990), but on the other hand, there are also questions about CAI's effectiveness for language minority students (Dunkel, 1990; Roblyer, Castine, & King, 1988). Furthermore, there are even questions about the validity of the existing studies in this area because of faulty research designs, measurement concerns, and lack of specificity regarding the utilization and implementation of technology (Olson & Krendl, 1990-91).

Although many educators admit that the notion of restructuring with technology is more of a dream or vision than a research-based approach, there is some growing evidence that suggests that technology can significantly improve the education of students in urban schools. Olsen (1990), for example, found that integrated learning systems significantly improved the academic achievement of minority students from several minority school districts across the country. This integrated learning system included (a) computerized, criterion-referenced tests that allowed for individualized assessment, (b) courseware providing interactive practice and feedback and covering basic skills, higher-order thinking, and problem solving, and (c) an instructional management system that allowed teachers to monitor and track students' progress.

In his report for the International Society for Technology in Education, Braun (1990) examined several projects across the country that found that technology-enriched schools had a beneficial effect on student learning. He found several examples of technology that improved at-risk students': (a) attendance, (b) achievement, and (c) behavior. He also found several schools and districts that decreased the dropout rate for students at risk. Although much of the evidence that Braun cites is based on expert judgements and anecdotal information, there appears to be strong consistency across these and other findings to support his conclusions. Descriptions of other technology projects such as Gross (1990), Kephart and Friedman (1991), and Wiburg (1991b) all involve students at risk and all support Braun's findings. More experimental studies, however, need to be conducted in this area before we can conclusively agree with the validity of these and others' claims of effectiveness.

Another area where more research is needed involves the specific ways technology impacts students at risk. Hornbeck (1991) lists several generic characteristics of technology that helps students at risk: (a) technologi is motivational, (b) it is non-judgmental, (c) it individualizes learning, (d) it allows for more autonomy, (e) it gives prompt feedback, and (f) it allows for mastery of content at one's own pace. Research is needed to verify these and other hypotheses related to *how* technology influences students at risk.

Matthew Effects Related to Technology Use

Although we know that students from disadvantaged backgrounds typically begin school already behind their nondisadvantaged classmates (Levin, 1990), what could be considered more critical is that fact that schools also contribute to these students' learning problems (Wang, 1990). Consequently, another factor that needs to be considered in the education of students from urban schools is the "Matthew effect" (Stanovich, 1986; Walberg & Tsai, 1983; Wang, 1990). The Matthew effect suggests that these disadvantaged students who are behind at the beginning of school or who learn at a slower rate will likely show a "progressive retardation" as they continue in school (Walberg, 1988).

Restructuring urban schools with technology has some important implications in terms of the Matthew effect. Several educators, for example, fear that the use of technology in the schools will create a Matthew effect and actually widen the gaps between high- and low-achieving students (Apple, 1988, 1991; Cummins & Sayers, 1990; Johnson & Maddux, 1991). Elementary and high school students from higher- income families, for example, are more likely to use computers in school and in their homes than students from lower-income families (Cole & Griffin, 1987; Jacobs, 1988; U.S. Department of Education, 1991b). Minority students in urban schools have also been found to have less access to computers (Office of Technology Assessment, 1988; Picciano & Kinsler, 1991). Furthermore, there has been very little software developed in languages other than English which may further disadvantage bilingual students in urban schools. Similarly, there appears to be several sex-related differences in terms of access to technology, with males being much more likely to enroll in both computer literacy and computer science courses than females (Jacobs, 1988). Furthermore, there are studies that have found sex inequities favoring males during classroom instruction related to technology (Koontz, 1991). In addition, there is evidence that there are some biases in computer software favoring males (Cole & Griffin, 1987).

Another serious educational problem is that we often teach students at risk less than they are capable of learning (Knapp & Shields, 1990). This aspect of the Matthew effect occurs when teachers interact or treat low-achieving or special needs students differently. There is evidence, for example, that there are differences in how computers are used in schools with predominantly minority students. In those schools, students typically work on tutorial and rote drill-and-practice programs, while schools with students from higher-income families generally use computers for problem solving and programming (Cole & Griffin, 1987; Office of Technology Assessment, 1988). While there is some evidence that this trend may be changing (Picciano & Kinsler, 1991), this general problem is one that needs to be seriously addressed.

Summary and Conclusions

In summary, while there is an abundance of literature on restructuring and restructuring urban schools, there is little research literature directly focusing on restructuring urban schools through technology. One possible explanation why technology may not often be considered an effective strategy for restructuring schools is that some evidence exists that technology increases the gap between high- and low-achieving students. Another explanation may be related to the high costs of integrating technology in schools. A third plausible explanation, however, is that many educators may just not be aware of the growing evidence that suggests that technology-enriched classrooms significantly improve urban schools.

The present article attempts to describe some of the issues involved in restructuring urban school through technology. Although recognition of the uniqueness of each school and classroom situation will always need to be considered, the accumulation of research evidence over time and across several studies may strongly suggest consistent findings that enhance our understanding of how to restructure urban schools and classrooms with technology. The first task towards the restructuring of schools is to examine our own professional knowledge (Glickman, 1991). Educators need to know both the benefits and limitations of using technology in urban schools. Furthermore, they need to know that technology alone is not an answer. Technology needs to be combined with properly trained teachers before it can be really benefical for students (Braun, 1991).

Improving the education of students at-risk in urban schools, however, will take more than just awareness of the problems and knowledge of some solutions. As Futrell (1988) puts it, "interrupting the cycle of desperation that defines the life of the at-risk child will require the concerted efforts of all educators" (p. 31). She also maintains that it will require an alliance among (a) teachers, (b) administrators, (c) university professors, deans, and presidents, (d) parents, and (e) the government. This will also require a call to action and collaboration among educators. This process requires a change in attitudes that will make all of us aware of the severity of the problems *and* seriously committed to reversing the cycle of educational failure for students in urban schools. Investing in technology and training may be costly, but if it reduces dropouts and increases student learning it is worth the investment (Braun, 1991). Educational technology may still have an important role in the current movement of restructuring urban schools, but educators must first understand its potential as well as limitations.

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Restructuring Teaching for High-Tech Education

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Abstract

As instructional technology becomes more obtainable for the classroom, considerable thought must be given to how this technology is to be used to improve the learning opportunities for students. This paper presents the professional development dilemma confronting teachers in the face of emerging technology, discusses who is responsible for preparing teachers for a changing environment, considers the skill teachers will require to capitalize on teachable moments in a hi-tech school, and provides a list of essential elements that one should include in a professional development plan. The author works with educators across the country, assisting them to integrate emerging technologies into their instructional strategies.

The Professional Development Dilemma

The school reform/restructuring movement is gathering considerable momentum, and leaders in and out of education are scripting plans for setting schools straight. Although many common strands seem to run through these plans, the one strand that is most lacking is that of professional development. Decision makers seem to assume that teaching is teaching, or that teachers will be so energized by their new surroundings that adjustments will come willingly and naturally. Whatever the motivation, failure to address professional development as a cornerstone of school reform will almost certainly doom the best of intentions.

Current teaching methodologies have evolved through many generations. Today's teachers employ the same basic strategies their teachers used, and one cannot expect teacher reform to naturally follow school reform when teachers have no models. One cannot expect teachers to be any more adaptable to a technologically enriched environment than have been other professionals who are a product of the industrial age.

If low-tech industrialized teachers are to adjust to a reformed high-tech school, one must first understand that a prototype classroom in a re-structured educational environment cannot be defined. The immediate future of education promises to be far too dynamic to yield credible predictions, and, in fact, early into the twenty-first century, one may be hard pressed to find a single location that can be adequately defined as a classroom by today's standards.

Current methods for teacher preparation were reasonably successful when almost all classrooms were cut from the same template, but such standardization is very unlikely for the future. Teacher preparation programs must be capable of providing more global preservice, rather than concentrating on specific skills suited for a static and predictable environment. They must opt to empower teachers with skills that will allow them to succeed in a fluid educational environment where requirements change daily.

As the methods of teacher preparation change, so too must the personal characteristics of those who are being trained. Individuals who, in the past have pursued teaching for job security and personal stability will most likely need to go elsewhere. Already, teachers are finding that they must now be persons who are flexible and more responsive to continuing change. Teachers must be prepared to survive in an environment of evolving technology. They must be able to accept greater individual accountability and assume reduced protection from an institution that continues to fall into public disfavor.

Acceptance of student-centered learning as a cradle to grave personal responsibility of each citizen is about to transform the school into a place to which people go to work with a mentor, gain access to technology, and validate their intellectual progress. Those who want to teach must be weaned from a need to be at the center of each student's life. They must be prepared to provide students the time and indulgence required to conduct an interdisciplinary exploration via direct contact with multimedia technology. They must be prepared to direct students to the proper resource, rather than to the answer, and to help students to turn a sometimes random exploration into a meaningful experience.

Teachable Moments and Learning Styles

Teachers in a technologically reformed school environment must be capable of diverging from a prescribed course in order to capture a teachable moment. Too often in the traditional classroom, teachers have not had access to the resources required to address a tangential inquiry at the moment it is of highest importance to the student; however, continuing emergence of multimedia technology will empower those teachers who have the tolerance and expertise to capture such moments by using their technology to explore side excursions.

Limitations of time and resources have prevented teachers from capitalizing on the obvious benefits available through matching teaching styles with the diversity of learning styles. Although differences in learning styles have long been recognized, few educators have been fortunate enough to exist in an environment where these differences could be nurtured. The combined forces of school reform and technology are about to remove the lid from unexercised opportunity, and teachers must be prepared if they are to successfully assume their role in this process.

For example, suppose that students are to individually use a multimedia simulation that will allow them to visit and explore the country of Kenya. The traditional teacher will want to be sure that each student completes the exercise knowing the country's capital, location, major resources, population, and animals. This teacher will probably provide a worksheet to be completed while using the simulation, followed by a written quiz after the exercise. In essence, the teacher is delivering the message that these are important facts. Discard everything else you might learn.

In this example, traditional methodology does nothing to amplify the potential of the technology to provide for each student a personalized experience shaped to his style of learning. Providing students the technology to conduct a personalized investigation, and then constraining them with time limitations and a prescribed formula for learning, will rob students of the many teachable moments that would have surfaced if the students had been given unrestrained access to their flexible resource.

If instead, the teacher possesses the ability to bring students together and guide a discussion in which students are encouraged to openly share their experiences, then the teacher can use the technology to return the student to the center of the learning process. Serving as a mentor, the teacher can guide the student discussion, and can help students to draw the maximum benefit from their exchange of ideas and experiences.

Who's Responsible?

How do teachers acquire these skills? By and large, not from schools of education, for few if any schools of education include among their staffs people who have both the instructional and technological expertise to serve as models. But if schools of education will in fact admit their failings and reform themselves, they can serve as pedagogical change agents.

A second effective change agent can be the teachers' associations. Too long the security blanket for teachers, professional associations need to spend less of their resources on advocacy and more on professional development. Like it or not, most local school districts will place staff development as the final item of school reform, preferring the immersion method to one of planned transition. The teachers owe it to themselves to begin accepting responsibility for their own preparation for a changed future, whatever it may be.

Regardless of the organization that finally assumes local responsibility for professional development, it is unlikely that this agency will possess the internal talent required to carry the ball. However, even today, there are pockets of highly innovative and energetic teachers who have already damned the torpedoes, and who have assumed professional development as a personal responsibility. Although scattered, such examples of excellence are not difficult to locate if one is persistent, and it is imperative that these persons be recruited as models of successful change.

In conclusion, the limited span of their resources will continue to restrict the efficiency of low-tech teachers;

and their self-imposed constraints are certain to prove to be unacceptable in a reformed high-tech society that continues to elevate the standards of excellence. The responsibility for a transformation in teaching strategies belongs to everyone; however the accountability will ultimately rest with schools of education and teachers themselves. Therefore it is better to take action now than to wait for a future that is already here.

A Prescription for Preparing Teachers for High-Tech Schools

How does one prepare low-tech people to teach in high-tech schools? Here are a few essential elements:

1. Patience, particularly with current teachers who are being asked to re-tool their skills. No one wants to do a good job more than the classroom teacher, and no one fears failure more than the classroom teacher. Anyone who has been living in the classroom knows the helplessness of having lost control of a class. Teachers move toward change slowly, often because they fear the result if they fail.
2. Understand that the capabilities of the technology will always exceed teachers' ability to use it. Attempting to convert teachers into technicians results in needless frustration. Allow teachers to find a comfort level with one or two good applications they can use quickly, then allow them to grow over time. Do not become alarmed if they are only making superficial use of the technology provided, as long as their use is resulting in improved instruction for students.
3. Develop internal experts as rapidly as possible. Find those few who have a burning interest in the technology, nurture their interests, and establish them as experts among their peers. If they are successful, others will want to emulate them.
4. Always start from their level, not the level where you want them to be.
5. Be sure that the technology is available for personal use at a time when it is required. Trying to develop new skills without the adequate timely access to the right tools available is like hammering on cold steel.

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Schools, Restructuring, and Technology: Implications for Teacher Education

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Abstract

This paper supports the current notion that technology will have its greatest impact when implemented concurrently with the reform agendas of active learning and restructured schools. After reviewing related technological trends and their likely impact on the work world, the paper focuses on current issues for integrating computers into schools and the emerging need to restructure learning with technology. Finally, the paper addresses the implications of these trends for teacher education today.

As we attempt to prepare teachers to enhance learning with information technologies, it is helpful to periodically examine our assumptions and goals. In a general sense, many teacher educators supporting the increased use of technolgy would agree that: (a) technology will one day have a powerful impact on K-12 schools, (b) technology has thus far had a minimal impact on K-12 schools, and (c) teacher education is a critical component needed for effective implementation of technology-based innovations. In view of these assumptions, our mission as teacher educators should be relatively clear. We must help teachers obtain a good working knowledge of various computer-based technologies and promote effective strategies for integrating these technologies into the curriculum. Before attempting this, though, we should examine our larger goals. What is our vision of what these innovations will look like when they are implemented? What are some of the larger "non-technology" issues that may be critical for meaningful change to occur?

This paper addresses the questions posed above by supporting the current notion that technology will have its greatest impact when implemented concurrently with the reform agendas of active learning and restructured schools (Collins, 1991; David, 1991; Sheingold 1991). To provide perspective for this belief, I will first review future technological trends and their likely impact on the work world. These factors, I believe, should be considered as we develop our vision of what constitutes an appropriate education in the information age. Next I will discuss current issues for integrating computers into schools and the emerging call for active, restructured learning with technology. Finally, I will discuss the implications of these trends for what we are doing today in teacher education.

The Technology: Where is it Going?

It is beyond the scope of this paper to offer a detailed account of technological advances on the horizon. There are, though, some trends that should temper our perspective about technolgy in education. Many educators as well as business professionals agree that the industrial age model of schooling based on one-way dissemination of information is no longer appropriate in an information-based society. While active, process-oriented learning is not a new idea, many believe that technology provides a powerful medium that makes restructured learning environments more feasible (Moursund, 1991a). What, then, can we expect of technology in the coming years?

As we speculate on the future, it should be noted that it is relatively easy to forecast hardware and software advances in information technologies. Computing and communicating tools have been improving at the annual rate of some 25 percent for at least the past two decades (Dertouzos, 1991) and no reversal of this trend is expected. Projected advances by the year 2000 include optic fiber that will transmit 10 million conversations at once (Naisbitt & Aburdeen, 1990), the storage of a full length film on five one-gigabyte chips (Negroponte, 1991), affordable voice input that supports continuous, natural speech (Wetzel, 1991) and "groupware" that will allow people from remote workstations to collaborate naturally via networks (Tesler, 1991). Soon, every representation of human knowledge, civilization, and culture will be digitally encoded, stored in the computer's memory, and recalled and reproduced at a computer-based workstation (D'Ignazio, 1989).

Looking further into the future, researchers at Xerox Palo Alto Research Center believe that ubiquitous computing will gradually emerge as the dominant mode of computer access in the next 20 years (Weiser, 1991). Ubiquitous computers will come in different sizes, each suited to a particular task including tabs (inch-scale machines that approximate active post-it notes), pads (foot-scale machines that behave something like a sheet of paper), and boards (yard-scale machines that are the equivalent of a blackboard or bulletin board). Weiser projects that when almost every object either contains a computer or can have a tab attached to it, obtaining, transferring, and processing information will become an effortless task.

Overall, whether ubiquitous computing becomes the norm or not, we can safely predict that increased computing and communicating power that is easy to use will be available at declining costs. With improved information storage and retrieval, accessing information will become a trivial task. While state of the art technologies will continue to slowly "trickle down" into our schools, established technologies (e.g., videodiscs, CD-ROM, telecommunications) will become readily available. According to Collins (1991), the cost of obtaining these technologies will eventually become a non-issue.

Trends in the Work World

The changing demands of the information age have been well documented. Naisbitt's assertion that "we are drowning in information and starved for knowledge" has characterized our era and will continue to do so in the future. As the computing power and the amount of information increases, it follows that "people who can creatively analyze, edit, or act on information in ways that cannot be automated" will be highly valued in our society (Malone & Rockart, 1991). On the other hand, the unskilled and undereducated will command salaries that will match their value in an information society—not very high (Naisbitt & Aburdeen, 1990).

Access to information will improve as expanding hypermedia systems allow free (or at least freer) forms of information storage and manipulation. Toffler (1990) states that while conventional databases are good for getting information when you know exactly what you want, hyper systems are good for searching when you are not certain. "The new systems, by permitting intuitive as well as systematic searching, open the door for precisely the serendipity needed for innovation" (p. 177). He suggests that this form of information storage and processing points toward a "deep revolution in the way we think, analyze, synthesize, and express information" (p. 177).

Regarding the demands of leadership, there is a pronounced trend toward "replacing the manager as order giver to manager as teacher, facilitator, and coach" (Toffler, 1990). Toffler states that "the primary challenge of leadership in the 1990s is to encourage the new, better educated worker to be more entrepreneurial, self managing, and oriented toward life-long learning" (p. 228).

Trends in the work world support the transition from an industrial age model based on "top-down" standardization to an information age model based on initiative, self-management, and creativity. Hypermedia-based knowledge systems will allow users to explore new information in self-directed ways. Organizations of all types will require workers who can obtain and learn new information and collaboratively solve problems. Active learning with technology will be a critical component for conducting business in the information age.

Implementing Technology in the Classroom: Current Issues

While trends related to technology and the work world are relatively easy to forecast, it is much more difficult to predict the level of implementation of information technologies that will occur in schools (Moursund, 1991b). Research strongly supports the notion that educational innovations will not be implemented merely because they are a "good idea" that meet specified needs (Fullan, 1991). Successful implementation of innovative methods and programs requires attending to a complex web of interrelated factors that must be present to support any innovation. Technology-based innovations, though possessing unprecedented power and potential, are not exceptions to this notion. Research indicates that there are a great many impediments to implementing computer applications in the classroom (U.S. Congress, 1988; Strudler, 1991; Strudler & Gall, 1988. Major obstacles, such as inadequate computer resources, lack of teacher preparation, lack of planning time, and inadequate on-site support have been well-documented.

The prognosis for technology in schools, though, should not be perceived as gloomy. Broad experimentation has generated an expanding knowledge base that includes many promising uses of technology that enhance learning and teaching (U.S. Congress, 1988). One especially encouraging study documents the experiences that accomplished technology-using teachers have had in integrating computers into their classroom practice (Sheingold & Hadley, 1990). The purpose of the study was to describe the range of practice with currently available technology, the perceived value of these practices, and circumstances that may promote or hinder effective technology use. Significant findings of the survey include: (a) teachers are motivated by students becoming engaged in learning with technology, (b) the approach favored most by these teachers involves the students using the computer as a multi-purpose tool to make their own products, (c) using the computer has changed their teaching to a more facilitative role in which students work with higher level material.

Restructuring for Learning With Technology

While the overall effects of using technology in schools have been less than dramatic, the Accomplished Teachers Study (Sheingold & Hadley, 1990) suggests some important issues and future directions. By documenting the efforts of those more advanced in integrating technology, the researchers have provided us with a glimpse of where other teachers may follow as their resources and expertise grow. The findings highlighted above indicate that changes in classroom practice with technology fit well with the current reform agendas of active, constructivist learning and restructured schools. Increased use of technology appears to naturally move schools in the direction of active learning (Braun, 1990; Collins, 1991; Dwyer, Ringstaff, & Sandholtz, 1990; Sheingold & Hadley, 1990). In addition, both active learning and increased technology use require restructured learning environments that include a new role for teacher as facilitator, longer blocks of time for project-oriented learning, and shared, site-based decision making that optimize technological and human resources (Braun, 1990). While much has been written on active learning, technology, and restructuring, Sheingold (1991, p.22) states that "considerable synergy should result from the thoughtful bringing together of these three agendas." It seems that the fate of these reform movements are very much interrelated and much can be gained from viewing them as part of a "larger whole."

Implications for Teacher Education

Teacher educators who support the use of technology should strive to balance course content to focus on both the dreams and realities of our field. While teacher training suggests a model that emphasizes "how-to" keystrokes and skills, teacher education has an appropriately broader connotation that includes implementation issues and pedagogical strategies. In my view, we must meet both the training and educational needs of teachers as we help prepare them for the long, difficult transition toward effective integration of technology. We must help them develop the skills they need today to enhance their own professional productivity. In addition, we must also emphasize strategies that will empower them to embark on a career of teaching with technology in learning environments very different from what exists today.

As we consider the technology itself, we should help our students become comfortable with the hardware and software that is available to them while also "planting seeds" about what will be available in the coming years. While graphical user interfaces are minimizing the need to focus on "training" for specific machines, it may be a number of years before accessing, retrieving, and manipulating programs and information will be a trivial task for all users. As progress is made in this area, we should be able to gradually de-emphasize our focus on machines and place greater emphasis on teaching strategies.

Trends in the power and cost of computer hardware suggest that schools will one day have plentiful and appropriate technology available. Today, however, inadequate computer resources is still a significant impediment to implementing technology in our schools. Thus, we should again focus on today's realities while articulating a vision that includes future schools with ample resources. It is important that we help our students develop realistic strategies for using available resources. These can include using a computer as a teacher utility or as part of a one-computer classroom model. As teachers develop greater expertise and gain more computer resources, they can then expand their use of the technology. The "seed" of more plentiful resources, though, is a significant one. It is a key component that allows students to form a future vision that they plan to work toward.

Trends in the work world support the need for students who can use information technologies to gather information and solve problems. While increased access to information is an exciting prospect, it could be a mixed blessing. As Alan Kay warns, "Instant access to the world's information will probably have an effect opposite to what is hoped: students will become numbed instead of enlightened." As teacher educators, we must address this possibility. We must attempt to involve our students in active learning experiences in which they analyze information and solve problems with technology. We must endeavor to provide model learning environments in our classes—environments that teachers can attempt to implement with their students.

Unfortunately, research suggests that true integration will be difficult to attain. Sheingold and Hadley (1990) found that it takes five or six years for teachers to master computer-based practices and approaches that would constitute significant integration. On the other hand, research indicates that progressive applications of technology seem to be beyond the scope of what most beginning teachers can handle amidst the many demands placed upon them (Novak, 1991). Again, this suggests the need to create an awareness about what's possible with technology while also focusing on what might feasibly be implemented early on.

Interestingly, when I discussed the five or six year period suggested by Sheingold and Hadley with a class of preservice teachers, many were incredulous that it would take them that long. In most cases, my sense is that their vision of true integration involved a good deal of CAI and in general, a more limited view of technology use than was adopted by the "accomplished" teachers. Perhaps, though, incoming teachers with a good foundation will be able to significantly integrate technology in less time than it took their predecessors to become accomplished. Certainly they will benefit from an emerging knowledge base and more abundant computer resources.

Finally, the issue of restructuring schools seems to be relevant to students who are looking to promote change with technology in their schools. While this isn't an issue that I would delve into in much detail with beginning students, it seems to provide an important piece of the technology puzzle. As students develop a vision, it may be helpful for them to know that 45-minute class periods were created by educators and can in turn be changed by educators. It may also be helpful to discuss and model the changing role of teacher as facilitator that many restructured schools are adopting. For more advanced classes that cater to technology coordinators, the issue of restructuring appears to be more central to their mission. For all, though, viewing technology as part of the larger educational picture seems critical. All educators should formulate a vision of what can (and should) change at the classroom, school, or district level. And we, as teacher educators, should help our students develop both the skills and strategies to implement that vision.

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A New Model of Computers and Technology in Education

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Abstract

This paper presents a proposal outlining an infused model of computer and technology education for preservice education. The proposal focuses on the position that the true adoption of technology by educators will only come about through the development of infused training programs at the college level. Teacher educators will need to infuse computers and technology throughout professional preparation courses and content courses in order to insure that presevice teachers are prepared and capable of employing technology in their instruction.

The need for appropriate training of teachers and administrators in computers and technology has been recognized for most of the last decade (Cory, 1991). This is an issue that has been with us for quite some time. For example, as early as 1986 the *National Task Force on Educational Technology* called for a significant increase in the available training for preservice teachers, inservice teachers, and administrators. These training needs are felt by many to still be great (Fulton, 1988; Cory, 1991). Many teachers still feel woefully under skilled (Niess, 1991). It should not be surprising for us to find out that many teachers feel their students are more competent with computers than they are or that this perceived inadequacy may be the greatest hindrance to their effective use of computers and technology in the classroom (*The Computer Report Card*, 1989). It should not startle us that there is a strong call for increased competencies for preservice teachers, inservice teachers, and school administrators (Charp, 1989).

The traditional introduction to computers in the classroom is passé. No longer is it adequate for students to sit in front of an Apple IIe and learn about a variety of instructional games. Tomorrow's teachers will need to be able to use tomorrow's technology. The entire face of education is in transition and technology is one of the driving forces. It is essential that experiences be structured and delivered to the preservice teacher that infuse technology into education. Infusion requires the proper permeation of technology into the professional application courses and into the subject area courses taken by preservice teachers. Infusion will require far more than gamesmanship, it will require a thorough understanding of the role of technology and the ability to orchestrate instructional experiences sustained by technological systems.

The Task

While approximately 27 states have established requirements for computer education, most have been limited. Only the state of California has prescribed legislated expectancies (Kelly, Harris, and Shelton, 1990). For example, at the preservice level, the state of California requires that *every* teacher should be able to demonstrate a *working knowledge* of microcomputer hardware and system components. Furthermore, every teacher must be able to show competency in (1) application packages (including word processing, spreadsheets, data base managers, graphics, and communications), (2) instructional software (such as tutorials, drill and practice, simulations), and (3) instructional productivity software (including test construction, record management, instructional material design). If these requirements are typical of preservice entry expectancies, then we may have a problem in teacher education. We must ask ourselves the simple question, Will our current teacher education curriculum meet the growing technology needs of our students?

Perhaps in response to this very question the *International Society for Technology in Education* (ISTE, 1991) presented its guidelines at the National Educational Computing Conference. These guidelines divided the levels of teacher preparation into four distinct groups:

1. Foundations: for all teacher preparation programs.
2. Computer/Technology Literacy: for teachers of computer literacy or resource persons for a school.
3. Computer Science Education: for teachers of computer science in secondary schools.
4. Educational Computing and Technology Specialty: for computer coordinators and other technology leaders.

According to *ISTE*, the Foundation skills should focus upon providing **all** educators with: ...concepts and skills that build a foundation for applying computers and other hardware and software in educational settings. (ISTE, 1991, p. 13) In order to meet the these entry-level competencies we will need expanded instruction beyond the current requirements at the undergraduate level and added provision for graduate instruction for inservice teachers. These expectancies can be met only with the development of a program infusing computers and technology into the teacher education program. We must move beyond the concept of merely adding outcomes to an already crowded program of study.

The term infusion is purposely used to described the task before us. We often hear of *integrated programs* or of *articulated programs*, however, how we conceptualize these processes is critical to how we as teacher educators will approach the problem of technology for our students and therefore their students. For example, to integrate means to *unite with something else*, while articulation means *the state of being jointed or interrelated*; on the other hand, infused means *to cause to be permeated with something (as a principle or quality) that alters the usual for the better*.

As the demands of certification boards and state boards of education on teacher education institutions increase, numbers of available instructional opportunities decrease proportionally. The task before us becomes one of finding a way of deepening the learning experiences of the students without seriously increasing the breadth of the experiences. For years curriculum developers have created integrated programs of study resembling walls of *Lego* blocks. These blocks interlock thus forming an apparently solid wall of neatly organized courses of study. The drawback to this concept is the tendency for the blocks to be treated as if they are independent of those that occur simultaneously or that come before or after. Or worse, that the blocks can be replaced or interchanged without major revision to a program.

While we may never be able to supplant the *course* as the primary vehicle of instruction we can replace the concept that courses exist independently of others. Infusing a program of study with a set of critical elements requires that these elements become integral parts of the courses that follow or coexist. If such an approach is appropriate for fields of study such as educational psychology and multicultural education, it must be appropriate for computers and technology education as well. In such a program of study the critical features of technology (the processes and knowledges) would be taught at a foundations level with introduction of application strategies. The professional preparation and content courses would then expand upon these foundations by providing guided applications and opportunities for independent applications for the learners. Finally, in a

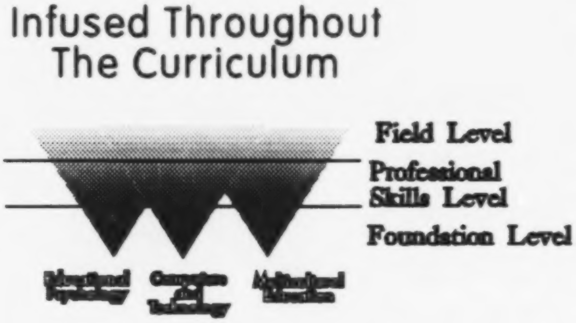
Infused Throughout
The Curriculum

Table 1: Learning Experiences

		Level	
Learning Experiences	Foundations	Professional	Field
The Technology Explosion in Society: Early Technology Advances Media, Computers, and Technology Multimedia, Hypertext, and Hypermedia	DI	IL	IA
Technology and Education Technology Systems: Hardware & Equipment **Media Systems** **Computer Systems** **Integrating Systems**	DI / GA	IL / GA	IA
Technology Systems: Operations and Software Understanding Operating Systems Characteristics of Software Evaluating Instructional Applications Evaluating Professional Applications	DI / GA	IL / GA	IA
Personal Productivity for Educators: Word Processing Data Base Management Spreadsheets and Graphics Telecommunications	DI / GA	GA / IA	IA
Professional Productivity for Educators: Management Software Presentation and Design Software Telecommunication Software & Equipment Multimedia Applications	DI	GA / IA	IA
Technology Applications & Process-Centered Ed: Integrating with Instruction Designing Instructional Experiences: Teacher Designing Instructional Experiences: Student Designing Instructional Experiences: Authoring	DI	GA / IA	IA
Problem Solving & Decision Making Cooperative Learning Experiences Employing "What-If" Simulations The Computer as Tutee	IL	DI / GA	IA
Technology in the Content Subjects	IL	DI / GA	IA

field-based model, learners should have ample opportunities for independent applications in their field experiences and student teaching experiences. Such a strategy might resemble the model presented in Figure 1. In such a model the darker areas represent the direct instruction levels of the foundation and become grayer as they are infused with the preparation courses, content courses, and field experiences.

Table 1 presents a breakdown of the eight essential learning experiences of the proposed program of study for computers and technology in education. The instructional nature of the elements is indicated as either Direct Instruction (DI), Guided Application (GA), Independent Application (IA), or Illustration (IL) (Demonstration). Each of the elements permeates throughout the preservice program of instruction. Under such a program of study students would receive their initial instruction in computers and technology in a foundation's course but the experiences would be elaborated and applied within the confines of the professional preparation courses and the field experiences.

One More Task

Perhaps our greatest need before we actually implement the program described above is in another area. We need to consider the barriers to employing computers and technology that are present in our own teacher education faculty. After all, many of the same factors that have been described as preventing teachers from adopting the new technology are also present in the teacher education faculty. Preservice and inservice teachers alike need to see their own teachers using technology because they, like other students, learn through modeling (Young, 1991). The use of technology must be a part of our teaching in order for it to become a part of our students' teaching. We must provide preservice teachers with continuous access to computers and related technology and require them to use these tools as readily as they use pencil and paper (Young, 1991). Such a requirement necessitates major changes in the instruction and application opportunities within teacher training programs as well as the very people who teach in them.

Summary

Effective teaching is not learned vicariously, it must be experienced and relished. We cannot assume that the mere presentation or demonstration of technology-related instruction by a Techie will be sufficient. We must direct and guide the effective learning and provide assurance that the experiences will be elaborated and expanded upon at the next level of professional development. Such a philosophy of instruction will require a new model of instruction. A model that responds to the learner at all levels of learning. Eisner (1985) describes the pedagogical process as being part *art* and part *science*. Eisner's *art* connotes individualization, motivation, and presentation of the learning experience. His *science* signifies the knowledge, skills, and methodology of the experience. Both must be present for successful teaching. The educator must understand and appreciate the nature, function, and principles of technological applications and systems and then must be guided in their use in professional and instructional activities. For too long have we assumed that effective application of any innovation merely requires cognitive understanding of it. Tyler (Madaus and Stufflebeam, 1989) was correct when he noted that true integration of an innovation demands cognition, an affective appreciation, and psychomotor facility.

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Models for Achieving Computer Competencies in Preservice Education

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Abstract

Adequate preparation of preservice teachers to use computers and technology in their teaching and learning remains a problem. Two questions to be addressed include:1) What do preservice students need to know and do? 2) How should the outcomes be achieved in the preservice program? The first question is addressed by the Accreditation Committee of the International Society for Technology in Education (ISTE). Two methods employed to achieve the outcomes are the core computer literacy course and the integration model. We need not choose between a computer literacy core course or integration paradigm, but rather the breadth and depth of knowledge required by the ISTE/NCATE competencies suggests that both a core course and effective integration are important components of a preservice program.

For a decade teacher preparation programs have struggled with the question of how to teach computer and technology use to preservice students. Despite our efforts, a survey by the U.S. Congressional Study by the Office of Technology Assessment (OTA, 1988) reported that 89% of all schools of education offer some form of computer training for their students, yet two-thirds of the graduates of teacher preparation institutions did not feel prepared to use computers in teaching. This causes many of us to ask ourselves these technology related questions: 1) What do preservice students need to know and do? 2) How should the outcomes be achieved in the preservice program?

In this paper I will examine two methods that different institutions have employed to meet the above questions.

What do preservice students need to know and do?

The first question, what do students need to know and do, has been addressed by the International Society for Technology in Education (ISTE), a professional society of computer using educators. ISTE's Accreditation Committee asked thousands of educators in K-12 and higher education to develop and rank a set of computer/technology goals for preservice education. These goals (ISTE Accreditation Committee, 1991) have been accepted by NCATE and will guide NCATE folio examiners as they evaluate the educational computing and technology preparation component of education programs. They are:

1. demonstrate knowledge and ability in the everyday operation of a computer system in order to successfully utilize software,
2. evaluate and use computers and related technology to support the instructional process in one's subject area,
3. apply instructional principles, current research, and appropriate instructional grading practices to the use of computers and related technologies,

4. explore and examine computer/technology-based materials in one's subject area, including experiences in using educational application software and documentation,
5. demonstrate knowledge of uses of computers for problem solving, data collection, information management and decision making,
6. design and develop student learning activities that integrate computing and technology for diverse student populations,
7. evaluate, select and integrate computer/technology-based instruction in the curriculum of one's subject area and/or grade levels,
8. demonstrate knowledge of methods for using multimedia and telecommunications activities to support instruction,
9. be skilled in using productivity tools for professional and personal use, including word processing, database, spreadsheet, introductory desktop publishing and print/graphics utilities,
10. demonstrate knowledge of equity, ethical, legal and human issues of computing and technology use as they relate to society and model appropriate behaviors,
11. use technology to access information and identify resources for staying current in applications of computing and related technologies in education,
12. use computer-based technologies to access information to enhance personal and professional productivity.

How should the outcomes be achieved in the preservice program?

Preservice training programs have attempted to meet these competencies in two ways: 1) a core computer literacy course (or competency model), and 2) an integration model (Eriksen, 1989). Even a casual review of the ISTE/NCATE goals suggests that neither alternative standing alone may provide the training that preservice teachers need. Certainly specific goals lend themselves to one or the other instructional format, and the knowledge and skills of teacher education faculty, as well as the specific computer resources of a particular institution, must be considered when appropriate program decisions are made. Nevertheless, some general observations may be made.

A computer literacy course appears to offer the best format for the following ISTE/NCATE competencies:

1 operation of computer systems,
5 problem solving, data collection, information management and decision making,
9 productivity tools for professional and personal use
10 ethical and societal issues,
12 access information to enhance personal and professional productivity.

A core computer literacy course offers a number of advantages according to Eriksen (1989). First he notes that the instructor will be knowledgeable about computers. This is a key issue in program planning for often general education faculty members have not had the training, access to hardware and software, interest, time or desire to become experts in computers, even within the scope of their own areas of knowledge. Eriksen cites other advantages of the core course: the course fits into the schedule, a computer lab can be used, and students will exit with predictable general computer skills.

A core course also has disadvantages. Eriksen notes that the course may occur outside of an instructional context and that computer knowledge and skills may not be applied within such a context. Furthermore, even if an instructional application is taught, it may not be taught by the best qualified instructor. To put it another way, is a computer education faculty member able to adequately teach the use of applications in mathematics or English language arts education? Perhaps the computer literacy and the methods instructors can work together to provide the optimal integration.

From my own experience at a university where all elementary teacher education majors took a core computer literacy course within the college of education, I had questioned whether a core course worked to prepare these teachers adequately. At that time I taught the methods course: Elementary Language Arts and Childrens' Literature. When I suggested to my students that they use the skills they learned in the computer literacy course to do their assignments (papers, lesson plan templates, field-based observation) for my course, many indicated that they had not used those skills since the computer literacy course was completed a year earlier. Informally students reported they had forgotten how to use the integrated productivity tool package and that access to the computer lab was a contributing problem. It seemed to me that transfer of learning from the classroom to the real world had not occurred.

I now have the opportunity to see if I can facilitate such a transfer. I currently teach a computer literacy course that meets a general studies requirement for all majors. About one-third of the students in this class are education majors. Will this core course empower students or will the application stop when the course ends? In order to improve the chances that students will be empowered, this course follows tenets of the model developed by Bitter and Yohe (1989) that emphasizes a practical and hands-on component teaching students to use a database, spreadsheet, and word processor and the integration of those applications. To encourage students to do assignments for other courses using computer applications, this activity was a requirement: students created a portfolio (20% of the course grade) that included copies of everything they did outside of the class using the computer, and a reflection page on what they learned as a result. The minimal requirement was that they complete six substantial pieces of work for personal reasons or to meet requirements of other courses. The six pieces had to include a mix of database, spreadsheet, or word processor applications. In addition, every effort was made to assure that computers would be available to students to accomplish their course work. In the future, these students will have access to computers on campus to complete assignments, thus they will not have the "lack of computer" problem described earlier.

Integration Paradigm

Although the core course is a good way to meet the competencies cited, other competencies may be given short shrift by this approach. The integration paradigm requires education professors to use computer technology to facilitate instruction in all curricular areas, allows students to observe methods teachers modeling the use of technology in their disciplines and to practice teaching with them. This is best accomplished as students observe methods teachers modeling the uses of technology in their discipline and as students practice teaching with them. Here students learn the specific software that experts in their field use as the tools of the trade. In mathematics methods courses this includes a variety of programs such as Logo, graphing and charting, spreadsheets, equation solving and graphing packages, statistics programs and computer assisted instruction. Here, students can be much more specific in their analysis of software as it relates to the particular tenets of a discipline.

It seems that the ISTE/NCATE competencies that remain - #2, 3, 4, 6, 7, 8, 11 - can best be met through an integration model.

Integration is not achieved easily. Again, I offer my own experiences as an example. I modelled the use of computers in my Elementary Language Arts and Childrens' Literature methods course. I used a computer with a projection panel to do group story writing. The use of a word processor provided an extended overhead transparency with the capability of recording student generated discussion in addition to my prepared outline. I distributed a copy of the class notes at the beginning of the next period as a review. I also brought significant pieces of language arts software to the students' attention and demonstrated appropriate uses of the programs. The integration was a lot of trouble. Support was almost non-existent. The overhead projector, computer on cart, and projection panel had to be requisitioned ahead of time and each came from separate offices, and the instructor was responsible for physically carrying each piece to the classroom and returning it to different buildings. At least two trips were required to obtain and return the equipment. Then the projection panel had to be connected to the computer (hopefully the power bar was remembered). Even for someone with expertise in technology and language arts, this arrangement made the integration onerous.

Inadequate support for faculty members has been noted by other researchers as well (Eriksen,1989; Bitter and Yohe, 1989). Faculty members without knowledge of the programs and applications in their fields will encounter additional difficulties—obtaining, previewing and evaluating software. Often the best way to learn new software and hardware is to have a colleague demonstrate it for you and/or provide a model lesson with it for your students. Nevertheless, integration must be accomplished. If we want students to teach the way they were taught, we must make it possible for faculty members to do the modeling. The ISTE/NCATE competencies #2, 3, 4, 6, 7, 8 and 11 can best be achieved when faculty members throughout the education department model effective computer uses.

Conclusion

The adoption of ISTE goals by NCATE has given direction to teacher preparation institutions as we re-evaluate our programs. Perhaps we are setting ourselves up to believe that we must choose either a computer literacy core course or integration paradigm, but a realistic reading of the breadth and depth of knowledge required by the ISTE/NCATE competencies suggests that both a core course and effective integration are important components of a preservice program.

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Teacher Education and Technological Change: A Systems Perspective

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Abstract

The way that teachers are taught influences the way that teachers teach in their classrooms. The way in which technological change is implemented during the teacher education process can be examined in order to assess how much or how little use of instructional technologies will be made by classroom teachers during their daily work. Besides ongoing educational partnerships between teacher education and the schools, the process of change itself is central in the development of any implementation of technological change. The use of an open system of organization in educational systems that recognizes teacher culture in the same manner of professional status as doctors or lawyers in other organizational change systems can be influential. Teachers as professionals can manage the level of integration that technology might have on the way that teachers themselves present the curriculum to their students.

Central to the development of any implementation of technological change is the process of change itself. The following questions will be discussed concerning the process of implementing technological change during the teacher education process:

- How is technological change implemented during the teacher education process?
- How is resistance to technological change managed from within the teacher education process?
- How can technological change be transferred from the teacher education process to classroom teachers during their daily work?
- How is technological change managed within the school organization?
- How are outcomes of technological change assessed within the school setting?

The focus of this paper will be on the use of technology in teacher education from a systems perspective. Suggestions are made for the development of an instructional system that can initiate the transfer of technological change from the teacher education process to its practical use in the school setting with a minimum of resistance.

Introduction: The current state of technological change within the instructional system

The rapid development of the personal computer as an instructional tool has had an impact on teachers, especially those teachers compartmentalized into teaching programming or computer literacy courses (Allum, 1991). These courses may be an elective to the math curriculum. A look at some of the current literature on educational technology in teacher education reveals that the personal computer is the primary technology under discussion (Fawson & Smellie, 1990; Munday, Windham, &

Stamper, 1991; Roberts, 1991). Most of the arguments presented in the literature concern the preservice teacher's introduction to current technology. Important, too, is the discussion of inservice teacher continuing education. Since instructional technology hardware and software upgrades are a constant reality, continuing education for the inservice teacher is needed as a matter of course. Currently, there are efforts to link colleges with K-12 schools either through partnerships (Allum, 1991) or electronic networking (Clement, 1991). These strategies for positive change may present challenges to individual teachers as their pedagogy becomes subject to observation by either cognitive or cultural anthropologists (Driscoll, 1991). Driscoll's observation is that the social context in which instructional strategy must operate must be looked at in order to weigh acceptance (1991, p. 33). It is important that teachers themselves be allowed to participate in the process of technological change. Qualitative methods of inquiry such as teacher ethnography allow teachers to gain control over the process of technological change as they themselves become change agents (Havelock & Havelock, 1973).

How is technological change implemented during the teacher education process?

Holmes (1986) observes policy implementation from an organizational perspective; the persons responsible for implementing the policy have to accept it. The dialogue between teacher educators and teacher practitioners has to be positive about accepting any changes to their profession. So far, one can imagine, this dialogue is one-way. State boards of education mandate programs of study in teacher education programs that do not adequately address technological change (Munday, Windham, and Stamper, 1991; Turner, 1989). Kemp (1991) has reviewed the role of technology in schooling by its uses, in historical stages, as society has a whole has adapted technology to its own uses. A few conclusions can be made from this review: (1) technology is an aid to teaching and is seen as a way to illustrate instruction; (2) technology is a tool of communication between teacher and student; and (3) technology can manage instruction that may be directed by the student. The way that the teacher education process views technological change in the context of the role of technology in instruction can determine how pre-service teachers will view the role of technology in their own future teaching. The context of the role of technology in an educational system that is open is flexible and open to changes that may influence students over their entire lifetime.

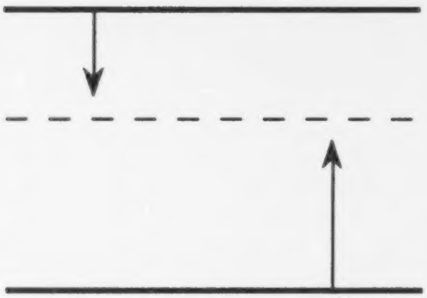
How is resistance to technological change managed from within the teacher education process?

Resistance to change can be viewed as a constraint in the organizational system model and can therefore be seen as a professional issue. Holmes (1986) defines a profession as a self-regulating organization. The organizational system model of a state regulated program of study for teacher education certificates does not seem to fit this definition of a profession because teachers, unlike lawyers or medical personnel, do not regulate their own profession. Since the public service role of teachers is confusing (Dichter, 1989) and the teacher education process does indeed vary from state to state, it is up to national professional organizations such as the National Education Association (NEA), the American Federation of Teachers (AFT), and the Association for Educational Communications and Technology (AECT) to work together to develop teacher education curricula that can be lobbied to individual state boards of education.

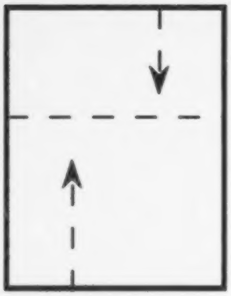
To develop professional teacher education curricula that make proper use of current and emerging educational technologies, a larger national context must be considered. While issues concerning local control should remain local, teachers' professional concerns transcend local issues. Concern for the use of technology should be a professional issue. It is appropriate at this point to discuss the difference between open and closed systems.

Organizational change in a closed system can be represented by a box (Jenkins, 1961) with a floating line representing the level of adaptation. Forces contributing to the level of adaptation to change can be represented by dashed-line arrows; the stronger the forces, the more pressure on the level of adaptation, in the case of technological change, either pressure to adopt or reject technology. In a closed system, the box is bounded from all four sides and the number of forces that can put pressure on the level of adaption relatively fixed; that is, there are just so many forces that can contribute pressure on the system before the system collapses. In an open system, however, the side boundaries of the box are removed so that the system can adapt to its context by adding greater numbers of forces that may, as represented by closed-line arrows, extend the volume of the system to new levels of adaptation.

The theory of the open system applied to physics and biology was advanced by Ludwig von Bertalanffy (von Bertalanaffy, 1950) as a way of investigating steady states in biological organisms. Educational systems can also be thought of as being non static. As a way to adapt to new social contexts, educational systems must open up their organizations as a way to adapt to technological change.



Open System



Closed System

How can technological change be transferred from the teacher education process to classroom teachers during their daily work?

System models can be developed within the constraints of the present political system since the teacher education process emphasizes methods courses rather than subject matter specialization (Turner, 1989). It is within teacher education methods courses that the idea of macrosystems, or process models, can be used so that teachers can create their own systems models using existing or emerging technologies as a delivery system. The emphasis here is on technology as a delivery system, although the process of instruction may be viewed as a technology itself. Current instructional design models for technology transfer (Fawson and Smellie, 1990) neglect teacher culture resistance to technological change because, in their models, teachers roles are shifted from "dispensers of information" to "facilitators of learning experiences." One can see how teachers can perceive themselves as being out of control of the teaching-learning process that goes on in schools.

How is technological change managed within the school organization?

Prepackaged materials seem to deprofessionalize teachers, making them technicians (Coe, 1986) rather than humanistic educators. Technological change used as a barrier to a teacher's individualized style of classroom management represents further deprofessionalization (Bastian, 1986), since, for example, local political control of federal money for technology, especially in the area of compensatory education (Mavas and Stickney, 1984), may be at odds with the way technology already is managed within the local school system (Bailey and Lumley, 1991). An open systems model for technological change would be appropriate to decide *at what level* technology would be used to assist handicapped students both within the district and at the individual building level with the help of administrators, building principals, teachers, staff, parents, and students themselves. This group, working collectively within their own local context, would act as a team to develop their own set of instructional goals concerning the appropriate use of technology that would work for their own students; this would be an emerging model and would be democratic since it would be done at a grass roots level. [Decentralization as a way of increasing participation (Holmes, 1986).] Holmes (1986) has adapted a model by Talcott Parsons that analyzes how members of formal organizations and others interact in the process of formulating policy changes. Persons may value a policy change based on the way they value the outcome. The qualitative linkage between a college's teacher education department and teacher practitioners allows a developmental change to take place that begins to professionalize the role of teacher practitioner as he or she becomes involved in the research of classroom pedagogy.

How are outcomes of technological change assessed within the school setting?

The way people manage technology in their daily work determines their personal productivity. Setting aside this thought for a moment, let's just look at the impact of technological change from a common point of view. Imagine what it would have been like thirty years ago to manipulate icons on a video screen with a hand tool aptly called a "mouse." Now, imagine back twenty years ago sitting in a living room with a tool called a paddle that moved a singular object—*pong*—across a television screen. The idea of change exists here as a developmental progression across society. The overall changes that are now taking place in education are quite radical considering the way both information is organized within the educational system and the way instruction itself is managed in schools. Questions such as "Should the school's computers be placed in each individual classroom, or should they be placed in one central location, the lab?" must be decided among those professionals whose daily work will be affected by the technology in question. Getting back to the idea of personal productivity, the concept of a learning laboratory itself connotes that it is a place where real learning does not take place because it is experimental, a laboratory. What comes out of a laboratory? Is the computer laboratory a common work center apart from the teacher-centered classroom?

The argument presented here is that when change is easily adopted, it will be a seamless process of integration that will not interfere with any traditional teacher culture resistance to change because the process of change has been managed within the teacher culture itself at the school building level.

Conclusion

It is possible for local school organizations to achieve goals set by the United States Secretary of Education such as *America 2000,* which specifies that the nation's schoolchildren will lead the world in standardized test scores in math and science by the year 2000. Implementation of the appropriate professional uses of technology at the local level will help teachers in their work. Moreover, linkages between teacher education and local schools can provide the best resources to manage technological change. Teacher education curricula must be developed in a national context to professionalize teachers.

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Computing in the Education Curriculum: Moving Towards Tomorrow's Classroom

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Abstract

This paper traces the influence of computing in the on-going development of the teacher training curriculum at SUNY Brockport. Early computer days included the use of Apple IIe computers. Graduating to the use of an IBM networked classroom for the math methods classes represented a significant step forward. Evaluation of the new classroom continues to present new opportunities and challenges including restructuring the curriculum and the addition of a new "Dimensions of Education" class. The results of student and staff assessment continue to play a key role in planning future enhancements.

Background

The use of computing technology has significantly influenced curriculum development in the Department of Education and Human Development at SUNY Brockport. This poster session is designed to trace the on-going evolution of the computer's growing importance in the teacher training program.

Over the years, significant grants from both Apple and IBM have helped to create the framework for incorporating computing into the education courses. Early work with a small number of Apple IIe's was done using Appleworks primarily for word processing of student papers, and some spreadsheet and database use. This use was not tied to teacher training *per se*, but rather was used to fulfill the college's computer literacy requirement. Limited computer resources were a drawback during this early period, although Apple computer did help to fund a Teacher Opportunity Corps program to place computers in a number of the student teacher placement sites.

A Title III grant was designed to help Brockport faculty begin to develop and refine their thinking about incorporating computing into the curriculum. A limited number of Education faculty members participated in Title III activities where revised curriculum guides were developed, although equipment shortage again made implementation and integration difficult.

Current Environment

In 1990, a grant from IBM to strengthen teacher training took the first big step towards alleviating the equipment problem. A networked lab of 15 IBM PS/2 Model 25's with a PS/2 Model 80 fileserver was dedicated to math methods students and located in an existing classroom. The grant, one of approximately 100 made nationally, included extensive training for the instructor running the lab, and provided a fairly wide selection of available software. For the most part, the network has proven to be very stable and requires little operational maintenance. The planned addition of more hard disk drive capability to the file server, and the acquisition of new software are positive indicators of its acceptance and use.

Structuring time in the classroom is one of the most challenging aspects of its use. During the first semester it was operational, class sessions were typically divided into three parts (Beers, Orzech and Parsons, 1991). Subject material was presented during the first third of the 90 minute class in typical lecture, question-and-answer style. The middle third of the class period was spent modeling the concepts presented through the use of concrete and manipulative materials. The last part of the class then attempted to show how similar concepts could be modeled on the computer. The software used was IBM's *Mathematics Concepts— Levels I-IV*.

For example, during a discussion of addition and subtraction of whole numbers, that concept is modeled first through the use of Base 10 blocks (concrete materials) and then using software which allow students to visually manipulate icons representing similar physical materials. Students value the work with concrete materials, but are also taught to make the translation from three dimensional objects to two dimensional computer screen images. They can better appreciate the need for similar conceptual development and sequencing of computer activities in their own teaching plans.

This outline continues to be the underlying framework, although subsequent semesters have required additional time for the computing component outside of the class period.

Feedback and Planned Changes

Results of assessment of the computer classroom, both formally and informally obtained through end-of-semester questionnaires and discussions with students and staff, have been systematically incorporated into the classroom's development. Student and instructor feedback after the first year (Fall 1990; Spring 1991; Fall 1991) of the new networked IBM PC classroom provided useful suggestions for further refinements. Specifically, students mentioned that they wanted additional hands-on computer time, and suggested the need for an instructor's station with a large screen projection system so they could see lesson plans modeled and develop their own demonstration techniques.

Students also suggested that computer use should be extended into other areas of the education curriculum. Encouraging other instructors to use the classroom has motivated them to become involved in integrating computing in their areas. There are now plans to incorporate computers into reading, science, social studies, education classes.

In response to the request for additional computer time, the curriculum has been restructured to include an entry level "Dimensions of Education" course. This class will include a computer component illustrating fundamental teaching applications such as creating lesson plans, evaluating classroom software, performance evaluation, and effective computer demonstration techniques. These tasks are designed to be useful across all areas of teaching specialization.

By learning how to use computers for pragmatic classroom administrative tasks, students will have a foundation that allows upper level courses to concentrate on the use of computers specific to the language arts, mathematics, science and social studies areas.

Fostering the computer's sense of excitement in subsequent years, and directing that energy into positive learning outcomes for children and their teachers will continue to be an ongoing goal of this project. Watching the development of Brockport's mathematics methods computer classroom from its 'shiny and new' infancy through its growing use as a model for others continues to be both stimulating and full of opportunity. More specifically, enhancements are planned to make better use of presentation software such as *LinkWay*, *Storyboard* and *Asymetrix Toolbook* for classroom demonstrations; extend cooperative WAN (wide area networking) discussions with surrounding school districts; and continue hardware and software acquisition and updating.

Continuing evaluation and feedback from students will be assessed to determine a workable balance of computing with subject material as we endeavor to provide tomorrow's teachers with the skills necessary to teach in the 21st century.

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Preparing Technologically Competent Bilingual and Multicultural Teachers

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Abstract

Computers are increasingly present in classrooms, but their use by bilingual teachers of limited English proficiency students is negligible. While linguistic and cultural diversity continue to increase throughout the United States, society's demand for technologically skilled individuals augments. Intercultural collaboration and conviviality are essential in our society. The introduction of technology in bilingual and multicultural classroom transforms the role of teachers and students. These role changes impact on preservice teacher training programs. University faculties should model technological applications in their courses. Since most faculty members are unfamiliar with methods for infusing technology across the curriculum, universities should encourage and facilitate faculty training in this area. Collaboration between school districts and universities can provide mutually beneficial resources for training teachers in the effective integration of technology and subject-matter content.

Introduction

The increasing number of computers in the classroom does not insure their use nor their infusion into the curriculum. Similarly, their presence in classrooms "has been accompanied by major discrepancies in. . .the relative degree of access, participation, and benefit enjoyed by particular groups of students" (Cummins & Sayers, 1990, p. 9). Indeed, fewer technological resources are available for children from lower socioeconomic families (Loop, 1986) and software specifically designed for various cultural groups is limited or nonexistent (Digranes & Digranes, 1989). A 1987 study by the U. S. Congressional Office of Technology Assessment found that twenty-two percent of teachers with limited English proficiency students use computers as compared to fifty percent of regular classroom teachers. In addition, the study revealed that only one percent of commercial software is designed for English as a Second Language students (Cummins & Sayers, 1990, p. 10). Considering the continuing increase in linguistic and cultural diversity throughout the United States, the soaring dropout rate, and the need to prepare students for a society that will demand greater literacy, cross-cultural cooperation, and technical skills, preservice bilingual and multicultural education programs must provide training in the use of technology for culturally and linguistically diverse children.

Changing Roles and New Skills

The infusion of technology into the bilingual and multicultural curriculum requires a concomitant restructuring of the classroom. The introduction of technology affects the organizational structure, our way of thinking, and how we accomplish our tasks (Hungwe, 1989). The effective implementation of technology for learning goes beyond an add-on or remedial approach to one of exploration, variation, and innovation. "Teachers need to understand that technology is not just hardware, or software, ... but is rather a process, a way of approaching teaching and learning" (Gooler, 1989, p. 19).

As a result of the infusion of technology across the curriculum, the role of the teacher shifts from didactic transmitter and critical evaluator to that of a resource facilitator, creator of learning opportunities, and co-participant in learning. Teachers will need to create a positive classroom atmosphere that stimulates cooperation, rewards effort, stresses thinking, responds to students' needs and differences, and integrates learning across the curriculum.

Not only does technology alter the role of teachers, but also the student's role. Students no longer will be passive recipients and compliant responders;instead, they will become active participants, critical-thinkers, and creative problem-solvers. As Munday, Windham, and Stamper (1991) state, "Students need to learn to explore their own interests, develop their own paths to learning, formulate their own problems, and seek their own solutions. They need to learn the lifetime skills of analyzing facts and formulating ideas" (p. 31).

These changing school, teacher, and learner roles demand the acquisition of new pedagogical and technological skills, as well as the development of cultural awareness and the acceptance of cultural diversity. Rubin and Averman (1990) describe good teaching as "student-centered, it respects individual differences among learners, and it requires flexibility in structuring subject matter" (p. 20). Research evidence suggests that sustained and controlled interethnic and intercultural experiences can have a positive impact on preservice teachers' understanding of cultural differences and acceptance of minority group students (Cooper, Beare, & Thorman, 1990; Grottkau & Nickolai-Mays, 1989). However, an awareness of one's own cultural perspective and values precedes an understanding of cultural diversity. This self-awareness underlies our acceptance and appreciation of other cultural and ethnic groups.

Despite the immense increase of minority students, our schools do not foster intercultural awareness and interethnic conviviality. Students need interpersonal skills that enable them to work and learn cooperatively in a pluralistic society. Therefore, teachers must facilitate intercultural experiences that promote positive attitudes towards all people in our pluralistic society. Traditionally, minority students learn about the majority culture; on the other hand, majority students have limited or no exposure to other cultures. The underlying implication is that the minority student's culture is less valuable than the majority culture. This lack of appreciation for cultural diversity perpetuates stereotypes, prejudices, mistrust, and misconceptions.

For teachers to effectively infuse technology into the bilingual and multicultural curriculum, they will have to know how various technologies, learning experiences, teaching methods, delivery systems, and classroom structures can benefit students from nontraditional backgrounds. A foundation in child development, learning theory, language acquisition theory and methodology, and classroom organization should guide teachers in evaluating the effectiveness of technological applications for their students. Teachers will need competence in using technology to address the needs of all students and skill in managing technologies as an integral part of the learning environment.

Undoubtedly, "the success of technology in education depends on the teacher's competence in using existing methods and adapting to future developments" (Bitter and Yóhe, 1989, p. 22). In addition to knowledge of computer operation, software applications, and technological advances, such as videodiscs and hypermedia, teachers should perceive computers and technology as enabling learning tools. An understanding of the pedagogical implications and applications of technology is essential. Moreover, a willingness to explore educational applications for future technologies will generate new possibilities. Bilingual and multicultural teachers must be confident in using a wide range of instructional tools and be cognizant of the limitations of existing technologies.

Restructuring Training

Preparing technologically competent bilingual and multicultural teachers presents a challenge to university administrators, college of education faculty, and school administrators. Effective changes in teacher training require cooperation and collaboration between school districts and universities. Both institutions should exert leadership in technology, research, and cultural diversity. Whereas university administrators and education faculty should commit to an instructional design that will generate technologically competent teachers, school administrators must provide on-going support of teachers through financial allocations for educational technology, provision for inservice training, and expansion of their own knowledge base. Bailey and Lumley (1991) succinctly summarize this concern stating that "coping with change—specifically technological change as it impacts teaching and learning—will be one of the greatest challenges of administrators in the next decade" (p. 23).

University commitment to preparing technologically competent teachers requires an examination of curriculum structure and content, as well as an awareness of available resources—human, technological, and economic. Although there are few instructional models "to assist in providing delivery systems. . .to prepare prospective educators for successfully using technology" (Bitter & Yóhe, 1989, p. 22), teacher educators concerned with producing competent and literate teachers can develop pragmatic and efficacious programs by first focusing on overall goals. These goals should reflect both the current body of research on teaching and teacher training, as well as community expectations and needs. The adopted goals then provide direction for the teacher training program.

If we acknowledge the need for technologically competent bilingual and multicultural teachers, then training programs should expose future teachers to hands-on experiences with technology. Future teachers "will use technologies only to the extent they are familiar and comfortable with the technologies" (Gooler, 1989, p. 20). Such familiarity assumes access to a variety of technologies and their use in a broad range of activities. Consequently, universities must provide education faculty and students with necessary technological resources to support such programs. Furthermore, these pragmatic and experiential programs require that faculty model the use of technology in their own teaching. By implication, university faculty should comprehend, incorporate, and teach about technology applications. However, most university faculty members have not kept current on technology developments nor been exposed to technology-infused curriculums. As a result, universities must encourage and assist faculty to become knowledgeable about and confident with technology applications.

Understanding the use of computers in their fields entails exposure to computers in methodology courses, direct observation of master teachers using technology, and noticing the reaction of classroom learners to technology. Thus field experiences reinforce and make relevant what is learned in university classrooms. Preparing master teachers to use technology requires inservice training that demystifies hardware, overcomes technophobia, and focuses on practical applications of technology for student learning. Collaboration between colleges of education and local school districts could provide preservice teachers with experience in technologies available in schools and inservice training for classroom teachers on technology applications (Nuccio, 1989). An example of such a program is being developed between Arizona State University West and the Howard L. Smith Magnet School. The project stressed writing across the curriculum in computer-infused bilingual classrooms. University faculty will provide inservice training for classroom teachers and education majors will serve as mentors for the elementary students through the exchange of electronic mail. Both the school and the education majors will benefit from the exchange.

Teacher training in classroom applications of technology should incorporate evaluation of software, in-depth topical reports prepared using computers, demonstration of teaching strategies that integrate traditional methods and technology, and presentation of mini lessons that incorporate technology. Awareness of various types of software, such as open-ended programs, tutorials, and drill-and-practice, is crucial to understanding computer assisted learning. In addition, teachers will need a repertoire of evaluation methods, such as student portfolios. Traditional standardized evaluation methods are not geared to the integrative learning that occurs in a student-centered, computer-infused school curriculum.

Ultimately, teaching is a multicultural experience in that classrooms reflect the school culture, the teacher's culture, the home culture of students, and the classroom culture created by students and teachers. Multicultural education addresses diversity across ethnic and racial groups, as well as within groups. Teacher training should provide a theoretical understanding of cultural diversity, as well as direct, sustained, and controlled intercultural contacts. Seminar presentations by minority group members focusing on cultural aspects such as family relations, values, beliefs, child rearing, and socialization will make preservice teachers cognizant of cross-cultural similarities and differences. Through the exchange of information and ideas via electronic mail, preservice teachers come into direct contact with other cultural groups and broaden their cultural knowledge. For example, preservice teachers can exchange electronic messages with classroom teachers and their students. This application models the types of intercultural experiences that teachers can provide for students. Other intercultural and interethnic activities include tutoring in racially, ethnically, and culturally diverse areas, student teaching in multicultural schools, and studying educational methodology in a foreign country.

Although technology will not solve all educational problems, collaborative work in technology-mediated activities can help limited English proficiency children develop greater self-esteem and peer acceptance. Computer-infused classrooms will provide technological skills needed in tomorrow's competitive work force. Children need gender and ethnic role models who use the technology encountered in classrooms in relevant problem-solving tasks. Teachers should model technological literacy. Thus schools of education have the imperative to make future teacher technologically competent.

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Education: Imperative for the 21st Century

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Abstract

Milwaukee Area Technical College, funded by a federal technical education demonstration grant, developed a summer teacher education course in collaboration with the University of Wisconsin-Milwaukee, industry, and local schools. The goal of the course was to instruct teachers in integrating academics and technical education. The culmination of the project was implementation of integrated curriculum in 3 pilot sites.

Framework for Change

With less than fifty percent of high school graduates going on to a baccalaureate degree and only 21 percent actually graduating, momentous steps must be taken to prepare the "neglected majority" (Parnell, 1985) for the work force. For local employers desperate for workers for the 21st century, the technical college is the bridge, leading first generation workers toward economic freedom and providing America with a competitive work force.

The Milwaukee Area Technical College (MATC)

The MATC district, with its 21 school districts, is a microcosm of the country, including a large (17 high school) urban school system with the highest teen pregnancy rate in the nation and a 40% dropout rate; a three high school system in a blue-collar community severely hurting from iron-belt unemployment; and a small rural district struggling to offer students alternatives to declining farming opportunities. MATC, a two-year technical college with a day, weekend and evening enrollment of 75,000 students, also provides a college-parallel Associate of Arts degree. Unique to MATC are its Adult High School and High School Contract Program. The Adult High School enrolls over 2,500 students and graduated 350 students in the past year. It is a fully accredited comprehensive high school, supplementing its academic program with vocational subjects offered through the High School Contract program. The program contracts with area districts to provide vocational instruction beyond what individual districts can afford.

Grants Providing Tech Prep Funding

The High School Relations Division of the MATC has federal and state grants for fiscal year 1992 in excess of $1,850,000. The Carl Perkins Act is the umbrella under which most of the funding was allocated. Included in MATC's funding are two major grants awarded by the United States Department of Education's *Project Hold*, a dropout prevention program, and the Technical Education Demonstration (TED) Program, funded in FY'91 for $436,000 and in FY'92 for $445,000. Grants awarded by the Wisconsin Board of Vocational and Technical Education finance *Project Second Chance II*, a drop-out prevention program with a post-secondary technical education component; and *Project Hope*, aimed at helping students prepare for and obtain admittance to the technical college. Carl Perkins Act grants administered by the Wisconsin Department of Public Instruction (DPI) provided funding for high school and MATC teachers to meet with industry representatives to identify entry level competencies and develop articulation agreements. Those funds now supplement the above grants by expanding the geographic area covered by the TED program and provide funding for additional teacher workshops. MATC, local school districts, area businesses and industry made additional commitments of funds to match in part the governmental expenditures, producing the most comprehensive tech prep programs in the state.

The Technical Education Demonstration Program

The TED program, a comprehensive tech prep program, is designed to serve only the urban district. It is under this grant that funds are available to develop the teacher training portion of the programs.

The TED program's mission is to facilitate attainment of academic and technical skills and provide access to technical employment by students between the ages of 16 and 25 who have been traditionally excluded from technical careers because of a lack of training. The major thrusts of the program are to: 1) improve teacher capability, 2) entegrate math, science, communication skills and social studies with technical education, 3) facilitate the transition of students from high school to the technical college through articulation, 4) provide student exposure to technological disciplines and thereby remove fear of the unknown and influence a career choice, 5) develop a model to provide education for employment, culminating in employment of fifty students in technical jobs following high school completion, and 6) Improve technical education curriculum through strong linkage with business and industry, providing exposure to current technology and integration of basic skills. I will not attempt to define the various terms used in the thrusts of the program but refer to "Integration of Vocational and Academic Education: Theory and Practice" (Plihal, Johnson, Bently, Morgaine, & Liang, 1991], which was used extensively in developing the program.

Training of teachers is necessary to break away from traditional teaching methods. Although excellent teachers frequently employ diverse teaching methods, it is more usual for academic teachers to teach as they were taught—through the lecture method, preparing students for four-year colleges and assuming students are able to synthesize and apply information. Anyone who has completed courses in teacher training can attest to hearing lectures on the importance of meeting different learning styles: the irony of the situation is that the entire teaching was done with one teaching method—the lecture. The purpose of integration is to change those teaching methods and utilize what has proven successful in teaching vocational courses to teach academics. Several means to reach the teachers were used.

A Teacher Training Program

In order to achieve the TED program goal of training teachers, three educational bodies collaborated with business and industry in implementing a summer program designed to help high school teachers in integrating academics and technical education. TED program personnel designed the course offered by the University of Wisconsin-Milwaukee School of Education for four credits. Local schools paid teachers' tuition or offered inservice credit. Classes were scheduled for 6 hours a day, 4 days a week for 3 weeks. Morning and afternoon classes alternated among the laboratory, classroom and industrial sites, where industry spokespersons explained what academic and technical skills new employees need. In support of the theory that more learning takes place by doing, almost no time was spent on lectures.

The goal of the course was to enable teachers to prepare students for the 21st century through exposure to technology and continued exploration of its interface with academics. The course objectives were to help teachers: 1) relate academic skills to work place application, 2) prepare educators to integrate technical education into existing curricula, 3) develop instructional ideas and techniques, 4) learn how technology will have impact on students' career choices, 5) give on site exposure to technical processes in the fields of manufacturing, construction, transportation, and graphic communications, and 6) provide hands-onexperience with the newest industrial technology, such as computer integrated manufacturing, robotics, computer assisted design, numerical control, automated handling devices, civil engineering, and electronic servicing devices.

Prior to the start of class, participants in the course were required to read *The cunning hand, the cultured mind: Models for integrating vocational and academic education* (Grubb, Davis, Lum, Plihal, & Morgaine, 1991) . Additional readings from current literature on integration of curriculum and class discussion followed. In the classroom the initial sessions focused on different learning styles, detailing the importance of and offering options for designing an integrated curriculum. Finally the participants formed multidisciplinary teams and completed team projects developing curricula for units of instruction designed to acquaint high school pupils with academic skills necessary to participate successfully in the technology-oriented work place. The participants were given about 9 hours for group work on their curriculum project in the first session.

A review of academic requirements for specific technical occupations and career opportunities in the fields of manufacturing, construction, transportation, and graphic communications took one day of the course. One-third of the class hours were spent in MATC technology labs. Participants in the class, both high school and college teachers, learned how math was used in civil engineering as they completed a simple survey. They wrote instructions on how to wire a circuit as they worked in electronics, concentrating not only on the subject matter, but also on the writing skills needed. They ran a simple program in basic robotics and heard about the impact of technology on the economy in computer integrated manufacturing, as it might be taught in a social studies class. Computer numerical control and computer assisted design were taught in the same manner, asking the participants in the class to identify the use of their particular academic discipline in learning the technology.

Because the instructors at a technical college are required to have extensive work experience, MATC instructors who were selected to do the technology presentations not only had connections with the work place from their own experiences, but could also utilize their contacts with businesses through members of their advisory boards to make arrangements for trips to business and industry. The TED program personnel prepared guidelines for the business and industry presenters to ensure they focused on usage of the academics in the work place.

The course was offered twice during the summer of 1991, with 13 students enrolled in the first session and the maximum of 15 for the second session. Adjustments were made as the course was presented. The first participants tended to concentrate solely on learning the technology, and had to be encouraged to apply the information to their specific disciplines. Rotating sessions between learning technology, class presentations, and visits to work places was useful.

In response to the first session complaints that the course took 12 hours of work a day for the 12 days of class, 3 class time hours were allocated for project work in the second session. Team projects varied greatly in quality. The anonymous comments of the participants at the end of the course were extremely favorable. They said: "Overall I feel the course was very worthwhile. I can now see how academic and vocational courses can work together." "I am impressed with what has taken place during this 3 week course. The hands-on work is interesting and shows me how I might relate technical areas to my students." The participants, who originated from different schools, left the class with the promise to instruct other members of their faculties in how to integrate curriculum and to attempt to try their projects at their schools.

The actual utilization of learning is the greatest measure of outcome. The three models below show some indication of the course results.

Three Models for Implementation of an Integrated Curriculum

The Technical Education Demonstration (TED) program targeted three Milwaukee Public School high school sites at which to facilitate an integrated curriculumin in FY91. A preliminary goal was to involve pilot site teachers in the summer school course. The sites were selected in the spring of 1991, to give administration time to schedule students and teachers and then give the selected teachers time to prepare. In all cases the first step was to obtain the support of top administration. Four of the participants in the course were involved in the pilot sites. We succeeded with four of them. From that point, the three situations diverged.

Integration at a High School for At-Risk Students

The MATC Adult High School courses are somewhat unusual. At-risk students are referred for completion of their high school diplomas through the various projects. Each class lasts 110 minutes per day for 9 weeks. The integrated program was designed by the TED project administration within the confines of the structure of the school; two vocational classes with enrollment limits of 15 students feeding into the academic classes with limits of 30 students.

All the MATC teachers were told about the project and many volunteered to be part of the pilot program. One teacher who previously taught Applied Math, using the curriculum developed by the Center for Occupational Research and Development, was selected to integrate his teaching with the teaching of instructors in Computer Assisted Design (CAD) and Welding. An Applied Communications instructor, using the curriculum developed by the Agency for Instructional Technology, became the fourth member of the team.

The Academy model was used, with each class of students enrolling in three subjects: Mathematics, Communication Skills, and CAD or Welding, known as block rostering (Grubb, Lum, Plihal, & Morgaine, 1991, p. 37). Time was allotted for the teachers to meet once a week to plan horizontal curricular alignment for the following week. This integrated program was offered prior to the summer teachers' class. Only one member of the four-person instructional team participated in the summer class. He was, without question, the strongest advocate of the integrated curriculum, and again part of the team when the integrated curriculum was offered a second time.

Student profiles presented the major obstacle—two academic classes and one vocational class (six periods per day) was too much for most of them to handle and the dropout rate was astronomical. Fortunately, the second 9 weeks we could change the program to integrate only one academic class with the vocational offerings. *The cunning hand, the cultured mind* (Grubb et al., 1991) discusses the tendency to segregate potential dropouts as a limitation to the Academy model. These conditions already exist at MATC's high school; its students are potential dropouts.

Several additional support measures were taken for the second session. During the initial offering the students had commented that they did not see any difference between their previous classes and the integrated classes. TED program personnel provided tutoring for students at the end of each class period. Small group work sessions were scheduled and students were encouraged to form study groups. Coherent sequences of courses were designed to enable students to move from Applied Communications and Computer Technology to Applied Math and Computer Technology II.

Integration at a Specialty School

At Custer High School, a Milwaukee Public School (MPS) with a construction specialty program, the administration took an even more active role. Just before the program started, MPS was divided into six districts, each with its own superintendent. The superintendent of the Custer High School district strongly supported offering an integrated curriculum and, to emphasize her support, wrote a request to the principal asking him to do everything possible to facilitate the actuality of integration. After several meetings with TED personnel, the principal selected faculty members to participate and the superintendent provided funds for coordination meetings. Tenth-grade mathematics, science, social studies, and vocational teachers were selected. The assistant principal determined the format for integration, making academic courses more vocationally relevant (Grubb et al., 1991, p. 23). Each of the teachers outlined the general topics to be covered in their courses. The assistant principal then spent hours examining the curriculum to determine how each unit could be modified to incorporate activities from the vocational courses. He assumed responsibility for programming the students into the block of classes and scheduling the teachers for common preparation times. The success of this program is due to the efforts of this assistant principal more than anything else.

After the curriculum was presented to them, all of the teachers were enthusiastic about the opportunity to implement it. Three of the teachers enrolled in the summer course. This certainly added to the understanding of integration. An innovative mathematics teacher adopted the curriculum for Applied Algebra, a superior course to the applied math taught elsewhere.

A facilitator was assigned full time to the school with funding provided by the TED program grant. One of her roles was to relieve the staff members involved in the integrated program of extra duties in order to provide common planning time. She also accompanied students to MATC so they could observe more sophisticated equipment and learn of opportunities in technical careers. Because the same group of students were involved in the entire block of courses, they were able to travel to other sites without missing a class. The students visited Harley-Davidson, Inc., a motorcycle manufacturing plant and an apprenticeship fair sponsored by the unions.

As a result of the success at Custer High School, planning has begun to provide for expansion of the program to the same group of students in their junior year. The 15 student class is much smaller than desirable for utmost utilization of teacher time, but this undoubtedly contributes to its success. There will be attempts to increase class size for fall of 1992. The integration of the academics and vocational classes will continue with next years' sophomores.

Integration at a Comprehensive High School

Riverside University High School (MPS) is a high school for the college-bound, with a manufacturing program to provide alternatives for neighborhood students and supplement the academic offerings. This school provided the third pilot site and appeared to have the greatest promise of success.

A group of teachers met prior to the funding of the TED program and devised a plan for integration. The TED funding provided a facilitator whose job would include bringing the resources of MATC to the school and assisting in implementation of the teachers' plan. The superintendent of this MPS district promised funding to allow the teachers time to plan and for remodeling so that the academic and technical courses could be taught in a cluster of rooms. The high school principal backed the plan and arranged for the initial meeting of the teachers.

Ninth grade students scheduled for pre-algebra and a technology survey course were to participate in the program. This program would be exceptional: it was to be a cooperative venture between the University of Wisconsin-Milwaukee's pre-engineering program, MATC, and Riverside High School. Students in the college track would be in the same classes as students in the tech prep program. Additional support in the form of tutoring and contact with the university, MATC, and businesses would be given to all the students. The TED program facilitator met with a number of families of potential students of the integrated classes to obtain their support for the pilot. Seventeen students were identified to enroll in the program.

In late August it appeared that the program was falling apart. None of the teachers enrolled in the summer course. The area superintendents' positions were eliminated and funding did not materialize. Despite the support of the principal, the assistant principal did not schedule the students previously identified into the classes. Another assistant principal in charge of teacher schedules failed to allow for a common preparation time as planned. And, to add to the difficulties, the vocational teacher who originally instigated the integrated curriculum received another assignment in response to reduced enrollment at the school. What might have been an ideal situation quickly became a disaster.

In the process, we learned many lessons: Even with very strong leadership from the top, every layer of administration must have devoted participants. A proposal by teachers may have their commitment, but implementation needs the involvement of everyone for scheduling to be successful. At least one teacher who is to be part of the integrated curriculum team should have the educational background offered by the summer course. A contract has now been developed to detail the commitment of the entire school.

The Riverside plan, certainly the most comprehensive integration program, is not dead. Students are still being transferred into the classes. The teachers' schedules have been altered to allow for a common preparation period. The central office has allocated funding to allow for an additional teacher to be assigned to the school to enable the flexibility in scheduling. The new vocational teacher is learning about his role in the integrated classes and we are expanding the program with everyone's role spelled out.

Plans are in the offing for an integrated curriculum at five more Milwaukee Public schools for fall of 1992. The schools were chosen on the basis of their vocational offerings, teacher participation in the summer integration course and involvement in articulation with MATC. The summer course will be repeated. The basic concept of these programs is to be replicated at nine suburban high schools, ranging from the rural school to a comprehensive suburban school. State administered Carl Perkins funds (Metro-Milwaukee Employment Articulation Program) will provide funding for teacher workshops to develop curriculum, and the schools will develop the integration model they feel is most appropriate.

Two coordinators will be hired to facilitate these programs, performing much the same functions as the facilitators at the Milwaukee high schools. The DPI grant (Metro-Milwaukee Technical Education Consortium) provides funds for this work. Milwaukee school personnel, urban, suburban and rural high school and technical college administration, and teachers are determined to lead the tech prep movement in the state.

Prepared under a grant from the Office of Vocational and Adult Education, U.S. Department of Education.

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The Future of Technology in Education: The Taliesin Perspective

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Abstract

The Taliesin project is an innovative curriculum and materials research and development effort to produce significantly integrated mathematics, science, and technology curriculum designed for delivery using a combination of traditional approaches and a high tech tool. Concern with poor performance in mathematics and science led to the formulation of the project. The changing role of teachers and training them to function in this new role are discussed. Teachers are critical to the Taliesin project and face two difficult challenges that are interwoven: the role of facilitator of learning and master of the classroom technology. The task of preparing teachers to meet these challenges is inherent to the project.

The Taliesin Project is an innovative curriculum and materials research and development effort. The project has two intertwined goals:

1. The development of significantly integrated mathematics, science, and technology curriculum designed for delivery using a combination of traditional approaches and a high tech tool.
2. The development of a computer aided classroom learning/instructional tool based upon networked hypermedia technology.

Concern with poor performance in mathematics and science led to the formulation of the project. Taliesin has three major objectives:

1. An integration of mathematics, science, and technology curricula for grades 6 through 8.
2. A hypermedia delivery system to support teacher guided cooperative learning/instruction.
3. Tools to facilitate the modification and creation of lessons by classroom teachers and students.

While the goals of the project are admirable and the technology is possible, one major stumbling block is the changing role of teachers and training them to function in this new role. For the Taliesin Project to succeed, teachers are critical, but they are faced with two difficult personal challenges that are interwoven—the role of facilitator of learning, since much of the information to be learned will be housed in the hypermedia system and other resources, and master of the classroom technology.

Overview of the Taliesin Project

To put these challenges in perspective, a brief description of the Taliesin Project is necessary. Although hardware and software are the most visible components of the project and are problematic, they are actually secondary. The principle focus can be seen in the derivation of the name, Taliesin. Taliesin was a character in a Celtic epic poem who was described as being able to instruct the universe. The goal of the project is to produce an environment where, if not instruction, at least learning occurs.

Basis of the Project

As indicated above, concern over poor performance in mathematics and science provided a specific focus for the project. There are a number of reasons that students perform poorly in these areas, they include mathematics and science anxiety, lack of value for mathematics and science, lack of motivation, and the form mathematics and science instruction usually takes. The anxiety usually forms in the later elementary grades, making the middle school years critical if students are to overcome it (Hackworth, 1985; Meece, Wigfield, & Eccles, 1990). One approach to overcome the anxiety is to attack the problem of value. When students value mathematics or science, the anxiety is lessened. In order for students to value the subjects, the instruction must be relevant. To achieve relevance, the instruction must take a form that allows students to find answers to questions like "When are we ever going to use this?" (Hazen, 1991; Saunders,1981).

Motivation is critical in this process. Anxiety, lack of value, and the inability to find answers to meaningful questions all contribute to a lack of motivation. To overcome the problems, students must become motivated. Student interest must be captured and curiosity levels raised (Keller, 1983; Martin & Briggs, 1986). Students must be stimulated to ask their own questions and find and share their own answers.

While the ability to ask questions is important, it is not sufficient to improve motivation. The answers to few, if any, real questions that students might ask confine themselves to a single discipline such as mathematics or physical science. Instead, they cross discipline boundaries. "For example, the issue of pollution from a local manufacturing plant has links to technology, chemistry, biology, sociology, and economics. The segmentation [of disciplines] increases students' difficulty in finding the relevance of the material. Answers to these questions require consideration of information from more than one discipline" (Smith & Westhoff, in press).

Segmentation also has implications for teaching practice. Teachers are not trained to present ideas or skills from disciplines outside of their area of expertise, limiting their ability to assist students' efforts to find answers. In addition, the segmentation promotes a competitive atmosphere, making collaboration across disciplines difficult. The issue of segmentation is being dealt with through the use of block scheduling of courses in middle schools (Becker, 1990). Using the block approach, a common theme is presented from multiple points of view with the emphasis shifting from facts to process. As the emphasis shifts toward process, the role of teachers shifts from disseminator toward facilitator (McPortland, 1990; Steen, 1989). The role of facilitator is often unfamiliar for practicing teachers and the transition can be difficult.

The Taliesin Solution

The Taliesin Project solution to the student problems discussed above is: "To capture the interest and curiosity of students, a 'richly-textured environment' using several large example systems that embody the mathematics, science, and technology to be studied will fuel the multidisciplinary approach. Use of the examples will raise the motivation level of students and provide multiple pathways for exploring student questions and relationships across disciplines. Central to the learning environment is cooperative learning that has been shown to work across ability levels and with diverse populations (Johnson & Johnson, 1987). Students will be actively engaged in the process and products of mathematics, science, and technology. With teacher guidance, students will explore possible answers to their questions within the context of the example systems. The learning environment will include in-class experiments, simulations, tutorials, textbooks, films, videodiscs, and computer-delivered or accessed information..."(Smith & Westhoff, in press).

To support this solution, the technological system in the typical classroom will include several student workstations networked to the teacher station. All will be connected to shared resources such as printers, scanners, and CD-ROM players. In addition, a laserdisc system and large screen projection devices for whole class presentation will be connected. The whole class presentation facilities will be operated from any station, at the discretion of the teacher. The entire system will also be connected to the outside world (on-line services and other classrooms). The system will have limited instructional material. Its major purpose will be to provide the tools to find information and manipulate it, to create materials and relationships on an individual and group basis.

Teacher Training

The combination of the instructional/learning approach with the technological support system will allow teachers to more readily guide students to finding personal relevance for the material to be learned, increasing motivation and success. However, this combination also creates the difficult challenges for teachers identified in the introduction of this paper. For the Taliesin approach towards education to succeed, teachers need to be trained in four areas:

1. Operation of the hardware and software,
2. Facilitation of learning (guiding the students to make

their own choices and learn),
3. Multidisciplinary approach to teaching, and
4. How to teach students to use the hardware and software effectively.

Operation

In order for teachers to effectively operate in a Taliesin classroom, they must be comfortable with the technology. Comfort is achieved through extended exposure and use of hardware and software. This does not mean using a word processor everyday to prepare short papers, which only achieves comfort with the word processing package. Teachers need to use of a wide variety of software packages (instructional and application, perhaps even some programming) for a variety of meaningful projects on several computing platforms. The process begins slowly with writing a paper or report and learning the basics of the word processing software used. The instructor or mentor for the teachers focuses attention on the process of word processing rather than the specific software used. As experience is gained, teachers are asked to produce materials or reports requiring the use of other kinds of software, graphics, spreadsheet, and database programs. The focus is always on how to accomplish the task at hand, not on the software itself.

Through this process, teachers are guided to learn the patterns associated with word processing, on-line bibliographic searches, graphics packages, and so on. As experience is gained, teachers are asked to use different packages on different computers, learning the idiosyncrasies of each system as needed, with the focus on accomplishing the task. The teachers experience and evaluate instructional software, learning how best to use the software with their own students.

While ideally these experiences begin long before teachers decide to become teachers, they can start whenever the teacher or teaching student becomes interested. The keys to success are working on meaningful projects (papers, microteaching, role playing, etc.) and learning the patterns found in computing software. Knowing the patterns allows the teacher to have an objective—copy and paste a paragraph in a report—and find the appropriate commands regardless of the system in use.

For teachers who face single computers in the classroom, stand-alone computers in a lab, or even a networked lab with a computer resource person, comfort may be sufficient for effective use of the technologies. In the Taliesin classroom, it is not enough. The classroom includes a variety of hardware connected with wiring that closely resembles spaghetti. Teachers in this setting must overcome cable fear, the feeling of being overwhelmed by all the wires and not knowing what plugs in where. As in the case of software, the solution to cable fear is gradual, meaningful exposure to connecting hardware. As teachers become comfortable with the software, they are exposed to simple single computer connections (monitors, printers, modems), with emphasis on types of connections and connectors. Gradually more types of peripheral devices and connections are added until a network can be connected. The purpose is not to turn teachers into technicians. Instead, they need to be comfortable with connecting and disconnecting devices with cables and setting the software environment to account for the simple changes.

There is a second reason for needing this level of comfort: in all complex technological systems failures are common. Since the system is likely to fail at any given moment, teachers need to learn how to compensate. That is they need to be able to maintain the active learning environment of the classroom even when the technology does not work. Learning these skills is accomplished through example, participating in a class where the technology fails and the instructor adapts, and microteaching experiences, the teacher (as student) prepares a lesson using technology and must adapt to a situation where some part of the technology fails, completing the microteaching experience.

Facilitation

Facilitation is as much an attitude as a set of skills. In a sense, it begins with the ability to adapt to new or unexpected situations, such as the hardware needed for a presentation failing to work. Facilitating learning is adapting to new and unexpected requests for information, resources, or guidance. Facilitators in education respond to those requests positively and guide learners to find the information. At best, the attitudes can be modeled for teachers by placing them in situations where their instructors act as facilitators. The hope is that the teachers will adopt the same positive and encouraging attitudes and that they will feel the extra time required to guide a student to information rather than simply provide it is worth the effort.

Successful facilitators need to be comfortable with the fact that they do not have all the answers. Instead, they know some of the answers and have a wide variety of strategies and resources available to help find answers. This requires both knowledge of information resources available and their location (books, journals, and people) and the skills necessary to access them. These are largely information and communication skills, which may or may not require the use of computer hardware or other technologies. In addition, the successful facilitator knows how to ask questions that will help students identify their own resources or better define their questions. Information and communication skills and questioning techniques can be taught and practiced in teaching methods courses, workshops, and technology courses. The approach is to provide direct instruction on the rudimentary skills. Then the instructor models the process while guiding teachers in discovering additional techniques, developing their skills through the experience.

One of the most critical aspects of facilitation is collaboration. Teachers in other discipline areas are excellent resources when searching for answers to complex problems. In facilitating student learning, teachers begin to collaborate, combining resources, knowledge, attitudes, and skills to help students. Collaboration can be encouraged in training teachers through group projects, with groups made up of teachers in different disciplines. Another approach is to use group projects requiring teachers to play different roles on the team. The idea is to promote collaboration by immersing teachers in collaborative experiences, where success for the individual is dependent, in part on the success of the collaboration. This is similar to the cooperative learning model.

Multidisciplinary Approach

It can be said that having a multidisciplinary approach to teaching or learning will lead to collaboration. But, in training teachers, collaboration is used to develop the multidisciplinary approach. To a large extent, being multidisciplinary means to use all available avenues of inquiry to find a solution to a problem or an answer to a question. It requires a willingness on the part of teachers and students to enter unfamiliar territory, where they do not have expertise. They must be willing to admit they do not know the answers and either ask people who do or consult other resources such as books, journals, or databases.

Collaboration can be used to provide experiences that encourage teachers to develop multidisciplinary attitudes. By working on projects in groups where success for individuals is dependent on group performance, teachers are encouraged to learn from each other. The instructor can facilitate the process by arranging projects where different roles are required or individuals must be able to explain the solution developed by the whole group.

Simply having a multidisciplinary attitude personally is not enough for a teacher using the Taliesin approach to be successful. In many classrooms, the teacher is the authority, the disseminator of knowledge. In the Taliesin project, the teacher is not the disseminator. This can give rise to fears about how the classroom will be controlled and about how the teacher will appear to the students; perhaps by admitting something is not known, students will have less respect. Whether the fear is justified or not, it can be overcome.

There are two parts to the solution. The first is to train teachers in classroom management styles that support group investigation of ideas and student initiative. In the process of learning the management styles, teachers need to experience them from both the student as participant perspective and the teacher as manager perspective. As before, instruction takes the form of microteaching projects and reflective discussion.

The second part of the solution is contained in the Taliesin hardware and software system. As the teachers are taught to manipulate the system, they are introduced to the wide variety of resources available through the system. These resources include hypermedia software that provides links across disciplines. The connections might be video sequences, text passages, references to books and articles that are not on line, or electronic mail from an expert outside the school. Because the resources are linked and easily accessible, the system encourages the curious to explore further. If the teacher can become comfortable with the process of seeking information through the system, then the role of facilitator and mentor will become exciting and generate respect.

Teaching Students

Comfort with the process of seeking information and comfort with the hardware and software on the part of the teacher is the starting point for teaching students to use the system. The positive attitude as a model will help students overcome the sense of being overwhelmed by technology, not knowing where to focus attention when. Helping students become comfortable users of the system requires a knowledge of what operations are important at what times in the student experience. The approach is to teach the students the skills they need to accomplish a given task when those skills become relevant. There are two parts to this approach. First, teachers need to be able to identify which parts of the system are needed for given tasks. That knowledge is gained as the teachers become familiar with the system and its capabilities. The second part is a knowledge of the strategies for teaching the students to use the system. This knowledge is gained through the training process. As teachers are trained, the steps are modeled; they are trained using progressions that are similar to those needed to teach their students. As teachers are trained, time is taken to reflect and discuss how they would approach the same skills with their students. This reflection and discussion allows the teachers to develop the strategies that will work best for them and for their students.

Teaching for the Future at UNC

Technology training for teachers at the University of Northern Colorado has been designed with this practice, reflection, discussion philosophy as a common emphasis. A sequence of three technology courses for teachers are used to begin the process of achieving the comfort level necessary for easy operation of technology. Two of these courses are intended for preservice teachers. The third course is a graduate level course intended, in part, for inservice teacher training.

In the preservice technology courses, training focuses on the first two areas: operation of the software and hardware systems and the facilitation of learning. Throughout these courses, concrete examples of using technology within the classroom are presented and modeled by the instructors. This modeling provides preservice teachers with techniques and strategies they can incorporate into their own teaching styles.

In the graduate level course, training focuses on the facilitation of learning and techniques for teaching students to effectively use hardware and software. In this course, discussions center around the applications and implications of several modeled examples of classroom technology use. Teachers are asked to derive the steps needed to teach their students to use the technology. In addition, the teachers extrapolate additional ways technology could be used to facilitate learning for their students.

In all three courses, participants represent a wide variety of disciplines, from music to chemistry to physical education. The collaborative projects within each course provide a micro-multidisciplinary experience. In this experience, participants are encouraged to share and apply the perspectives of their own disciplines to the development of unique solutions to the problems posed in the projects. This multidisciplinary approach, though not yet common across the entire university, will be a key factor in the future of technology training for teachers. (A more detailed discussion of the course sequence at UNC is presented in Munson, Westhoff, Bauer, & Smith, in this volume.)

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Using a Local Area Network to Develop Writing Communities

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Abstract

A local area network can be used to teach writing by developing communities of discourse, both within a class and among several classes. How such communities are developed and what effects are achieved through them will be demonstrated by examples from a local area network using Novell *NetWare* and *RealTime Writer* to teach an introductory course in college composition. Technical and human problems associated with the enterprise are also discussed.

For all but the last decade or so, the predominant model of learning how to write in college was that of a linear, stimulus-response feedback loop. A solitary student would respond to a written text with a written text, and a teacher would then respond to the response with marginal notations and with an occasional oral assessment during office hours. Under ideal circumstances, this model would resemble a bilateral conversation between mentor and protege, but all too often the model was characterized by conflict rather than by cooperation. It was often a Sisyphean attempt to please a pitiless master. Another feature of this pedagogy was the emphasis on writing as a product. The student was allowed one version only, and that version received an unappealable grade. In the classroom, the teacher lectured or analyzed writing to a mute, notetaking class. Writing was done outside not inside the classroom. This hierarchical, teacher centered model inscribes into pedagogy the social dislocations (isolation, autonomy, and elitism) that literacy enforces outside the classroom (Tiger, 1987).

For slightly more than a decade, however, the predominant mode of learning how to write in college has been that of a nonlinear, open-ended network. A student still responds to written text with writing, but responses come from peers as well as from the teacher. The responses, moreover, are often expressed orally within a group of students sitting in a circle within the classroom. The teacher circulates from group to group or engages in direct oral assessment during the class. The classroom is also the locus where writing begins. A second major feature of the current pedagogy is its emphasis on the process of writing, from free writing through the final draft of a piece of discourse. The emphasis is not on the finality of writing but on its contingency. The students work in cooperation not in isolation and competition.

The newer model of composition teaching is labor intensive for student and teacher alike, and it requires students to expend unusual amounts of energy in writing and revising multiple drafts of papers that may extend to five or more pages. Although students enjoy the privilege of not receiving a grade until after revisions, many balk at the amount of work required. The advent of the personal computer and its incorporation into the classroom has facilitated the writing process and the acceptance, among faculty members as well as among teachers, of the process-centered method of composition. The computer has also fundamentally altered perceptions of writing so that the model of the fixed text has been replaced with that of fluid intertextuality (Heim, 1987).

The standalone computer, however, does little to foster the peer interaction and the establishment of a writing community that is also essential to the newer pedagogy. The technology that allows the computer to enter fully into this pedagogy is that of a local area network. With a local area network, students and teachers become part of writing community, the flow of critique is increased, and the belief in the solidity of writing (as represented by the printed page) is tempered by the electronic fluidity of writing. In addition, the disjunction of in-class oral commentary and writing that characterizes peer groups is dissolved in that orality becomes textualized.

In recent years the Samuel Rudin Academic Resource Center (ARC) at Iona College has experimented with using a local area network to develop writing communities. The center houses two electronic classrooms that are used primarily for instruction in introductory composition. Each room has sixteen IBM P/S 2 computers available for student use, and each has a teacher's work station that also functions as a print server. Each classroom is also equipped with a Hewlett-Packard LaserJet II printer. All the machines are part of a fifty-station Novell NetWare 286 local area network that includes faculty, administrative, and student computers in the Academic Resource Center itself. All the monitors are VGA color monitors, and each computer has a hard disk drive that varies from 30 to 60 megabytes. The server is a 120 megabyte IBM P/S 2 Model 70.

The target group under study is freshmen. All entering freshmen are required to sit for a series of placement tests (a writing sample, a test of reading ability, a test of sentence structure, and a test of arithmetic and algebraic skills) that complements the Scholastic Aptitude tests and the Test of Standard Written English. Students whose performance on the complete suite of tests indicates that they are not prepared for the college's regular freshman composition course are required to enroll in and to pass Introduction to Composition. These are the students who form the group being studied.

Using word processing, a classroom-specific message system, and a local area network to teach students with low-level writing skills has been effective in producing better writers because these technologies facilitate both a process and a peer-group approach to writing. The computer systems enable teachers to implement more fully and to test the value of teaching writing as a process and within a community.

Students enter Introduction to Composition already aware that writing is a weakness, and consequently they neither like to write nor discuss their writing. One way to break down this reluctance is to remove the judgmental voice of the teacher and replace it with the supporting voice of peers and with a teacher's voice that is advisory and affirming. This process can be accelerated through technology because students come to college fascinated by electronics and because process and peer-centered writing can be more effectively realized with rather than without computer technology. Also, the computers create an environment that is simultaneously intimate and anonymous.

The benefits of using word processing to teach composition have been well documented, and the experience of students at Iona College supports the notion that word processing provides students with a firm sense of their ownership of writing, that it facilities revision, and that it produces writing that is free of spelling errors. (Turkle, 1984; Feldman & Buford, 1987) In addition to easing the production of formal composition, students in Introduction to Composition develop facility with writing by free writing on the computer for five minutes at the beginning and at the end of each class session. Word processing is also used to help students develop editing skills. Students retrieve extended passages of text that are replete with errors, and they correct the errors on the screen. The texts used are usually well known works that have been scanned into ASCII files and then contaminated with grammatical and other errors.

The accessibility of these files is made possible through a computer network that connects two electronic classrooms, a tutorial center, and administrative and faculty offices. Faculty members have developed a database of these passages that are available for retrieval from any work station. Faculty members can create these documents, as well as tests, at their desks and have them stored on the file server. The security levels available in Novell NetWare allow faculty members to fine tune students' access rights and their ability to make changes in files. Students retrieve these assignments, some based on grammatical and others on organizational elements, on their screens and revise them. After thirty or so minutes engaged in this process, class discussion begins. Students can then amend their responses so that they can save to their own disks a perfected assignment, which they can later review. If assignments are to be graded, students can still save corrected assignment after the assignments are discussed in class.

The main benefit of the software, however, is not in its replication of a textbook on a computer screen. Its main benefit is its capacity to establish a process-oriented, peer-centered approach to writing that makes students fluid writers and adept editors.

The first step in this process is to reduce students' anxiety about writing. The best way to loosen writing inhibitions is to have students spend the first and last five minutes of each class engaged in free writing. Although some students feel hampered in this endeavor by a lack of keyboarding skills, emphasizing the nonevaluative nature of the assignment by not having the writing saved and by stressing that it will not be graded or even viewed by the instructor relaxes these tensions and suggests that writing can be written without being subjected to an ego pulverizing criticism. A variation on this is to have the students turn off the monitors so that there is no immediate visual feedback, which makes the free writing more like speech.

Once students have gained some facility in putting words on the screen—usually about two weeks into the semester—they can be introduced to *RealTime Writer*, a software package that allows students to conduct on-line conversations among themselves. Using channels, students can be paired or groups of any number of students can be created. The first time this is used it is best to have the students interview each other about their lives, personalities, and interests. These interviews can then be the basis for a brief biography of the other student. Because of the flexibility in the arrangement of the channels, students can be anonymous to each either, and this promotes the flow of discourse. Teachers who have worked with students in small groups and who have used the electronic group universally assert that the latter yields more commentary than the former and that the commentary is more focussed in its electronic rather than in its oral mode. Also, in the personal group the most extraverted member tends to dominate, and those who are more deliberate of thought and speech tend to silence themselves. In the electronic format, immediacy of response is not a sine qua non for the progression of the discussion, and the force of personality tends to give way to the force of ideas and commentary. The excitement generated by electronic discourse is indicated by the frequency with which discussion of topics and compositions spills over into oral discourse and continues after the class has ended.

After about thirty minutes using *RealTime Writer*, students are sufficiently familiar with and comfortable using the system for it to be employed in sharing writing and in research. In terms of sharing writing, students save their work without their names on it to the file server. Files are then retrieved by students who make comments on the work. Only the author knows who wrote the piece. The author receives comments from the entire class, and part of the goal of the class is for the writer to weed out criticism that does not help in writing and to respond the criticism that does help.

RealTime Writer can also be used to enable students to work cooperatively. For short projects, students can generate topic sentences that their partners must develop into paragraphs. Students can become online editors of each other's work. Some instructors even like to give students the option of submitting for grade a paper composed by two or more students. If these tasks are undertaken, it is important for the integrity of the class that groups be varied over the course of a semester. This enables students to form bonds with all students in the class, and it prevents a feedback cycle of failure on the part of some groups.

While using *RealTime Writer*, the teacher has the capacity to monitor and to intervene in the discourse on the channels. This capacity should be used judiciously to ensure that the discussion is kept on track and to direct the discussion into new areas. The teacher also has the capacity to have a transcript of all the channels for analysis and printing out. The transcript reveals that students exchange more words and focus more assiduously on the task at hand than they do while sitting in groups. Moreover, having the discussion take place in virtual silence makes classroom management easier, and it also reduces distractions generated by oral discussion.

For assignments that require research, the network supports the creation of working groups. Student accounts can be established that allow members of the group to store files that only other members of the group have access to. The most common use of this feature is for the storage of notes relating to a written or, more typically, oral assignment. Because of the cooperative nature of this, students have access to more information than they do traditionally , and they obtain practice in sifting through more material than they would otherwise obtain. Students also use this feature to leave notes to each other about their progress in completing assignments.

One of the major aims of using computers in the classroom is to remove the tyranny of the printed page. Indeed, some instructors do not have students produce hardcopy at all, and these same instructors do not handout printed material. Because of the network, faculty members can create assignments in the privacy of their offices and then store them in the subdirectory reserved for their classes. In turn, students can send material to a common area, and they can receive their annotated work in the same manner. Also, faculty members are better able to present students with writing for analysis during class. Faculty can extract portions of students' essays and create a separate file that can be downloaded during class for oral discussion or for practice in editing.

One of the most startling effects of using the network and its file storage areas is that the classroom becomes expanded both spatially and temporally. Students can gain access to their network areas from several locations, and soon they will be able to gain access from nearly every major facility on campus. Student interest in completing assignments is so high that they tend to send documents at odd hours of the day and night. Even without having a bridge between the Samuel Rudin ARC and the rest of the campus, students still save material on their disks at the dormitories or at twenty-four hour a day locations and then transfer them to the network. [The college has just begun laying fiber optic cable that will be the backbone of a campus-wide network directed by an IBM mainframe.]

Although the major use of the system described here is in the teaching of composition, the system eases the introduction of writing into other parts of the curriculum. For example, a teacher of developmental mathematics at Iona College regular uses the messaging system feature of RealTime Writer to engage students in writing projects of various sorts. During class, for instance, he will broadcast a question, such as, "What are the various types of interest?," to the student terminals. The students discuss their answer over the network, and groups of two come up with mutually acceptable definitions which they then broadcast to other groups. At the end of the class, the students can vote on the most comprehensive and the best written definitions. Also, the channel feature allows students to put onto the screen both the steps in a mathematical process and words describing those steps. Again, groups can cooperate in this process. The mathematics teacher has finds that this procedure helps students work together cooperatively outside of the classroom as well as inside it. The percentage of students from classes with the messaging system using the Samuel Rudin ARC in small groups is much greater than for classes that do not use such a system.

Although having the equipment and software available is a necessary condition for developing electronic communities, it is not a sufficient condition. Faculty members must believe in both the peer method and in its electronic implementation. Of equal importance is the ability of the faculty members to embrace change and to have a sense of curiosity and wonder about the new technology. Without these human elements, the network would lie inert, and students would continue to operate as isolated monads.

The program has had more success than anticipated. Students have readily embraced both the new technology and its use to foster the process and peer-centered pedagogy. One measure of their enthusiasm is that students wait outside one of the electronic classrooms starting at 8:00 am for an 8:30 am class, and students tend not to want to leave the classroom at the end of a session. Moreover, students in these sections write longer, more detailed essays than their peers in the advanced composition classes, and they have better attitudes about writing as evidenced by their responses to questionnaires at the end of the semester. Some faculty members have been inspired by the new technology, and they continue to find new uses for it.

A recent study compared the performance of two groups of students in college composition: those who had been through Introduction to Composition and those who were placed directly into the college-level course. Both groups had comparable pass rates, but those who received remediation passed with lower grades than those who placed directly into the course. This indicates that Introduction to Composition reduces but does not eliminate differences in level of preparation. Anecdotal evidence also suggests that the remediation reduces differences. Each year faculty members teaching college composition are surveyed at the end of the year to determine their reactions to students who have been through remediation. The faculty members have no formal way of identifying such students. Almost uniformly, the faculty members report that there are no differences between the performance of those students and other students.

Although the implementation of this system has proceeded with fewer problems than expected, it has not been without incident. There have been three categories of problems: those that are purely technical, those that arise from interaction of technology and human desires, and those that are purely human.

The purely technical problems are the least severe because they can be rectified by one technically competent person within a short time period. For example, because of a mistakenly modified command file, one of the network's remote print queues in a classroom was defined so that some print jobs were printed in the classroom and others were sent to a printer on the floor below. This resulted in confusion for and annoyance among the students in the classroom and the administrators and faculty members who used the other printer. Some detective work and a few calls to the vendor solved this problem.

Problems that arise from the interaction of technology and human desires pose a continuing variety of difficulties. The primary human desire in question is that of wanting immediacy of results. Students will, for instance, send a document to a printer a multiple number of times if it does not appear at the printer within minutes. That the reason for nonappearance is that the printer is out of paper deters few students. As a consequence, multiple copies of documents are printed and students have to wait unnecessarily long for their print jobs to print. Another problem arises when students, either through haste or lack of awareness, ignore or misinterpret prompts from Word perfect 5.1. Students will often merge many copies of a document into a file. Carelessness also causes problems.

The command sequence for a hard page break in Word Perfect 5.1 is [CTRL-ENTER]. This key sequence is easily reproduced by a misplaced elbow or a book bag. As a result, some students produce hundreds of blank pages and then print them out. The result is the mistaken belief by some students and laboratory assistants that the printer is acting aberrantly. Although the cause of these problems is difficult if not impossible to eliminate, the symptoms can be readily cured.

The purely human class of problems has been the most intractable. That class elucidates what Marvin Minksy's terms the Papert Principle: "Some of the most crucial steps in mental growth are based not simply on acquiring new skills, but on acquiring new administrative ways to use what one already knows." (Minsky, 1986, p. 102). The biggest problem has been convincing faculty members to use and to experiment with the electronic environment. When technical problems arise, teachers are frequently immobilized by them, and this stalls the teaching of the class and communicates incompetence to the students. The presence of the computers makes flexibility in teaching essential. In order to counteract faculty reluctance and ignorance, the Samuel Rudin ARC conducts training sessions on a monthly basis in computer related topics. The center also has on staff several graduate students who have technical expertise in the network and in word processing.

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Structuring Teachers' Attitudinal Changes: The Project CHOICE Experience

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Abstract

Early attempts at introducing computers into the classroom centered around introductory inservice courses that often left teachers frustrated and alienated toward technology. This study discusses the results of the first year of a project designed to affect teachers' skills and comfort levels in using computers, and their attitudes towards them. The project itself is described, along with an analysis of the pre- and post-tests designed to capture teachers' perceptions of computers and their comfort and skill levels with respect to using computers for instruction.

Educational change depends on teachers. What teachers think and do with respect to an innovation governs the possibilities for success of the program. When the change involves the use of computers and advanced technology in the classroom, the task is compounded by the attitudes toward the technology that teachers have at the outset.

That teachers' thoughts and reactions to change affect its success or failure has been generally accepted, (Fullan, 1982; Sarason, 1982); however, how to measure those thoughts and actions and effect desired changes in them is the subject of continuing research. The Concerns-Based Adoption Model (CBAM) (Hall & Hord, 1987) is a well developed framework designed to be used by change facilitators in choosing appropriate interventions to influence the attitudes and behaviors of participants. In this model, as in others, (Knupfer, 1990; OTA, 1988) the point is made that training is a necessary but not sufficient factor in successful implementations of innovations. These studies recommend continuing follow-up beyond initial inservice and on-site support. Hall & Hord (1987) go so far as to recommend that the availability of on-site expertise for support and frequent interventions by change facilitators is more effective than system-wide or school-wide day-long follow-up sessions.

In reporting on inservice training given in Alaska, Reidl and Via (1990) found very different outcomes in the three school districts receiving the training. Based on this experience, they contend that there are two key factors necessary to the success of a program intended to help teachers use computers. The first is access to appropriate hardware, software, and physical plant. The second is the support of someone on a on-call basis. The Stages of Concern questionnaire (Hall, George, & Rutherford, 1977), one dimension of the CBAM model, is designed to help facilitators monitor the concerns of change participants. Reed (1990) used the Stages of Concern questionnaire along with other modified attitudinal surveys to determine the effects of computer-based instruction on prospective English teachers. He verified Hall and Hord's assertions of the Stages of Concern (1987). The participants in the Reed study experienced a decrease in awareness- and management-related concerns and an increase in consequence-, collaboration-, and refocusing-related concerns. These changes Reed attributed, in part, to the amount of computer time the participants in the study were given.

Recognizing the need to reduce teachers' anxiety and build confidence, liking, and perceptions of usefulness toward computers, Project CHOICE (Curricular Help On Integrating Computers in Education) was designed to combine intensive hands-on training with follow-up and on-site support (Bauder, Planow, & Sarner, 1991). Administrators, collective bargaining unit officials, and teacher center directors were called upon to provide a support network for project participants.

Under a grant from the U.S. Department of Education, a series of graduate courses were offered to train teachers in the use of contemporary technology. In addition, participant groups met periodically throughout the school year to permit group support, evaluation, and refinement of projects in progress. College personnel were available at all times to assist the participants in their schools and to videotape their experiences in the classroom.

To insure transference to the classroom, participants required joint sponsorship by the school administration and the local teacher collective bargaining agent. Moreover, the sponsors were required to pledge their continuing cooperation for the project by providing participants the opportunity to test the materials developed in the classroom and to make time and facilities available for the participants to train their fellow teachers.

The goals of the program were to enhance teachers' knowledge and skills with respect to computer use, thereby enhancing their comfort levels as well. Since this was a self-selecting group, it was expected that pre-tests would indicate relative comfort with the use of the computer and a perception of its usefulness as an educational tool. The self-perceptions of knowledge levels could not be anticipated.

Methodology

A pre- and post-test questionnaire was developed to measure teachers' attitudes towards the educational use of computers, their own perceived comfort and knowledge levels, and their perceptions of the level of support and planning in their districts. This questionnaire was administered to the participants at the beginning of the project in June of 1990 and again at the end of the first year of the project in May 1991.

Participant attitudes were measured by reaction to eighteen statements along three dimensions: 1) general attitudes with respect to computer use, 2) level of comfort with respect to computer use, and 3) perception of their skill level. Responses were coded on a nine point scale and statements were both positive and negative to detect response biases. Twenty nine of the thirty six participants completed both the pre- and post-test questionnaires.

Since a central premise of Project CHOICE was that attitudes would be altered as a result of participation, analysis of each item necessitated excluding cases in which the participant indicated the most favorable outcome for an item on the pre-test. Thus, for example, a participant who indicated complete agreement with the statement "All teachers should be skilled users of microcomputers" would be removed from analysis of that item, since it was not possible to improve the score of a respondent already at the ceiling. The remaining pool of respondents were included in t-test analyses using paired samples.

Results

Eight of the questions probed general attitudes with respect to computer use. Typical of this group were statements like "Microcomputers are important pedagogical tools", "Microcomputers can assist the teacher in accomplishing a wide variety of educational tasks", and "All teachers should have a microcomputer in their classroom." On five of these items, no significant change was noted. This lack of change is not unexpected, as the selection process began with self-nomination by the teachers within their own school district. The participants would not have been likely to become involved in this type of project unless they already felt that computers were worthwhile tools. Once the participants were nominated, they had to be endorsed by their administrator and by the bargaining agent. If either of these did not feel that a potential participant was appropriately motivated, it is not likely that the nominee would have been granted the necessary support by the school district to participate in the program.

The three remaining questions on general attitudes deal with perceptions of how computers should be used in the classroom. On the questions, "All teachers should be skilled users of microcomputers," "Over the past year my peer's knowledge of, and experience with microcomputers has increased," and "I can see clear differences in the effectiveness of teachers using microcomputers compared to those who do not," the change was significant (at the $p<.01$, $p<.05$, and $p<.01$ levels respectively). While this study does not attempt to determine the specific reason for the changes, it is logical that this change in attitude is a result of having the opportunity to exchange ideas with a more diverse group of peers, and to find out what is being used effectively in other classrooms. It could also be viewed as a shift from self-centered concerns to those of consequences and collaboration.

Two of the questions dealt with the participants' comfort with respect to computer use. On the first, "In general, I feel comfortable using microcomputers to accomplish educational goals/objectives," twelve of the twenty-nine respondents on the pre-test indicated complete agreement with the statement. The degree of change in the remaining participants was not significant. Again the selection process caused only those with a fair amount of comfort using the computer to participate. The other question asked the participants to compare their comfort level with those of their peers. The change in this item was significant ($p<.01$). This change could be seen as a result of the multiple facets of Project CHOICE. The intensive two week summer course was a major catalyst. It was designed to involve more than 45 hours of hands-on training—an amount that far exceeds the usual inservice computer course offerings. In addition, the project team served as a support group for the participants once they went back to their school districts. The team answered questions over the phone and went on site when it was necessary to solve problems. While not many of the participants took advantage of the support, several expressed a sense of security that it existed. The follow-up sessions held throughout the school year also gave participants a chance to ask questions and get help if needed.

The third dimension of the questionnaire, consisting of seven items, was concerned with the participants' perception of their own microcomputer skills. By far the most concrete of the three dimensions, skill level, is also the most easily altered. It was in this dimension that Project CHOICE scored its most notable successes. Typical items in this area were "I am not knowledgeable enough about microcomputers to make effective use of them in the classroom," "When I face a new educational problem or task, I have sufficient knowledge to integrate a microcomputer in the accomplishment of the task," and "I know enough about microcomputers to teach others in my school/district." With the ceiling effect again controlled for, significant results ($p<.05$) were achieved on six of the seven items. Changes in this dimension are most likely associated with the intensive summer course and follow-up support. Another possible component is that of access. Participation in the program required that teachers be given sufficient resources to incorporate materials developed into classroom use. For some, this meant regular access to computers in the classroom or lab for the first time.

The sole item on which significant changes did not occur was "When I use a microcomputer in my classroom, it is usually because someone else has shown me how to do it." Teachers may attribute their own growth in skill level to the coursework and to experiences shared with peers during the follow-up sessions.

Project CHOICE was effective in raising the skill levels of participants. The assumption that they would bring to the program positive attitudes and a relative level of comfort in using computers was substantiated. Because these participants were sophisticated, having had considerable experience with computer usage, it is not surprising that attitudes and comfort level did not change appreciably. As participants were exposed to new, integrative computer activities, and as their skill levels were enhanced, our evidence suggests that they discerned distinct performance differences between colleagues using computers and those who did not. Furthermore, all three items calling for peer comparisons showed increases in participants' perceived competency relative to their peers. The change literature suggests that the full impact of intervention programs will not be immediately evident. Work in progress will examine diffusion patterns in the participants' schools, and attitudes of participants' colleagues who were not early adopters.

Project CHOICE is funded through a grant from the U.S. Department of Education Office of Educational Research and Improvement under the Secretary's Fund for Innovation in Education. Grant #R215A92073

Portions of this document will appear in "Computers in the curriculum: affecting teachers' attitudes", Proceedings of International Conference on Technology and Education, (forthcoming) Spring 1992.

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INSTRUCTIONAL TECHNOLOGY AND DESIGN ISSUES

The six articles contained in this section complimented one another very well. In fact, it would appear that the authors of these articles prepared their materials with the authors of the other articles in mind. All of these authors recognize that the average classroom teacher probably has little technical knowledge of computers and computer programming. What knowledge many classroom teachers have was gained by trial and error. However, with the increased demands being placed on classroom teachers, better ways are needed to design applications for use by the average classroom teacher.

Doris Lee proposes that software is often designed from the programmers' point of view, with minimal thought about the inexperienced or minimally experienced user. Lee's article, *Providing more oportunities for error correction in courseware,* describes the dilemma and suggests that more software is needed that allows the inexperienced user to learn to use computers in instruction without frustration. In her article, Lee makes several suggestions for programmers to consider.

Where Doris Lee ends, Doris Carey and Jeff Thomas take over in their article *A courseware design model focussed on students, teachers, and their curriculum.* Carey and Thomas report that teachers are often frustrated by a lack of software that is aligned specifically with their curriculum goals. Such a lack leads to abandonment of technology in the classroom. Carey and Thomas propose that it is necessary to involve teachers in the design software to fit the curriculum. By working with consultants, the teachers are encourged to articulate their needs. The consultants then create programming that fits the curriculum, incorporating good software that already meets the expressed needs. Of course, a cost is involved, but that would be minimized in a number of ways; for example, through the development of user friendly tools that would allow the teacher to adjust the software as needed.

In order to implement the process described in the Carey and Thomas article, the teachers would need better, more objective means to evaluate software across various instructional systems. Dale Hoskisson's article, *A descriptive tool for designing, evaluating, and studying computer-based instruction*, describes a tool he developed to design and evaluate computer based instruction. Based upon the theories of Gagne and Merrill, this descriptive tool appears to be a beginning in providing a means to objectively analyze computer based instructional software using different instructional systems and approaches.

Grace Lane and Matthew Shaver, in *Storyboarding: A creative technique for planning technology use in education*, applies the use of storyboarding as a planning technique in developing classroom applications of technology. While Lane and Shaver suggest the use of *Storyboarding V1.0*, this approach would probably work

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quite well in developing a unit in conjunction with an expert consultant.

In *Supercomputing and the science teacher: A state of the art challenge*, Helen Doerr describes the use of supercomputers with high school science classes. Through the *SuperQuest* program, selected schools have access to supercomputers and are able conduct experiments using those vast resources. Doerr discusses the strengths and problems associated with this program. Among those problems is difficulty in fitting the use of the supercomputer to the school's science curriculum. Proposed strategies to deal with the problems associated with this application of supercomputing are presented by Doerr.

A suggested use of the OOPS paradigm is described by Ralph Cafolla and Dan Kauffman in *OOPS: The state-of-the-art in computer science education*. The authors describe OOPS programming using very clear analogies, and discuss how it could be applied to teaching. Cafolla and Kauffman also suggest that Minsky's model of the mind and OOPS programming are analogous, and could provide a basis for explaining human learning.

Thus through these six articles one can move from the problems of why teachers may become frustrated with the use of computers in teaching, to suggestions on how to evaluate applications, how to gain outside assistance, and how to create your own assistance. Examples are given of how technology is being used in teaching, and how to better understand learning through technology.

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Providing More Opportunities for Error Correction in Courseware

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Abstract

When facilitating school teachers' computer skills, quality courseware that is very sensitive to the individual teacher's characteristics in terms of learning needs and difficulties should be employed. Still, many teachers have trouble using courseware that are considered to be effective by programmers. This problem happens because most courseware design is based on programmers' points of view instead of the perspectives of teachers. When teachers and programmers do not share the same point of view, teachers tend to get lost in learning with courseware. Possible solutions include the provision of more corrective, responding, and practice opportunities after errors. The importance of incorporating more query and responding opportunities within the on-line help context is also stressed. The provision of relevant information together with sufficient opportunities for enhancing desired skills ensures successful computer learning for school teachers.

Using Courseware to Facilitate Teachers' Computer Skills

Today, numerous schools are employing computers for instructional purposes. When computers are used in teaching, the key to success depends on how well the teacher can function with them. With better computer skills, the likelihood of a negative attitude toward using computers for teaching is decreased.

Many computer training programs are available for preparing teachers with the instructional uses of computers. Common subjects in these programs include basic hardware and software operations, word processing techniques, and simple programming skills (Ronen, 1990). However, as Bork (1984) and Ronen (1990) point out, teachers were not trained to use computers efficiently due to a poor program structure or inappropriate teaching methods such as lecture and textbook. Obviously, lectures or textbooks alone cannot provide effective instruction for computer skills that demand a great amount of hands-on experience.

Instead, quality courseware that presents a systematic design for learning or instructional purposes is more appropriate for facilitating teachers' computer skills. When teachers are learning computer skills, they should be allowed to learn according to their pace and schedule. They should be able to speed through the previously mastered materials. Moreover, they should be supplied with more opportunities to practice, whenever necessary, the skills they have trouble acquiring.

By using well-designed courseware to facilitate teachers' computer skills, teachers can engage in a continuous hands-on learning process. It will interact with teachers by asking questions and responding to their answers with positive feedback. Most importantly, it can branch to different presentations, modules, or practice activities according to their changing needs or learning difficulties. It is difficult to produce all the above learning activities in a classroom training program where one instructor teaches 20 or 30 teachers with different backgrounds and skills.

Providing Teachers with More Corrective Opportunities

Problems

Recently, researchers have found that the main reason some software confuses users is that the software was designed based on the designer's point of view rather than perspectives of the user. Once the users cannot follow the designer's ideas about how to use the software, they tend to feel lost (Jih & Reeves, 1991). Gery (1991) also stresses that the major problems in using electronic systems such as computers to support performance include inadequate help and context, "one-size-fits-all" lessons for diverse learners, insufficient practice opportunities for novice users, and inadequate responses to learners' needs.

Problems with Command Type of Interaction. Almost all the problems discussed above happen when courseware is employed for teacher training in computer skills. For instance, many teachers still have trouble learning with some courseware that is considered to be effective by designers. Very often, experienced programmers or software designers believe that the command mode is the fastest way to interact with the computer, while many teachers have difficulty in remembering commands. Such experiences would frustrate teachers who have very limited experience in using computers.

Problems with Practice Items. The other problem in using courseware comes from the provision of practice items. Most courseware provides the user with a proportion of learning content before practice. Some courseware evaluates each response and gives confirmational or corrective feedback, but some only includes a summary of the overall performance. In either of these cases, no extra corrective opportunities are offered to help users realize why a specific error occurs and how to correct it. Generally, inservice teachers who are novice computer users have a great amount of anxiety when asked to acquire computer skills on top of their busy teaching schedules. Under these conditions, if the courseware is not sensitive to difficulties and does not provide sufficient opportunities for error correction, they will feel insecure in using computers or even refuse to apply them in teaching.

More Opportunities for Error Correction

One essential way to provide teachers with successful courseware learning experience is to include sufficient opportunities in which teachers are allowed to correct their mistakes, replace their mistakes with desired performance, thereby experiencing successful learning.

More Opportunities for Correcting Inaccurate Commands. When an inaccurate command is given, the presentation of the accurate command plus more corrective opportunities following that erroneous command would be very helpful. When the correct commands and new trials are given, teachers can apply the accurate information to discover the correct answer in a following trial and, once again, experience success. Extra corrective opportunities are also helpful when the teacher is not sure what to do next and is constantly making careless mistakes. Suppose errors are simply produced by careless input, another try would force the teacher to respond carefully.

More Practice Opportunities during Instruction. As emphasized, all courseware should include as many opportunities as possible for teachers to recall prerequisite knowledge, to build linkages between the previously and newly learned materials and to practice desired skills. Specifically, courseware designed to teach computer operation procedures, word processing, or simple programming skills should include simulations or sets of interactive activities that provide continuous training in keyboarding, in retrieving and saving files, in using a variety of word processing utilities, and in basic programming techniques. Effective simulations together with plenty of corrective opportunities provide a nonjudgmental learning environment for teachers.

For those teachers who do not have any experience in operating computers, the provision of sufficient practice is a must. Teachers with no computer background can benefit from practicing the desired computer skills repeatedly. A teacher's specific learning problem can be detected through analyzing his or her responses to the practice questions. During practice, the teacher has to review and apply the learning content to answer the practice questions. After the courseware compares the responses with the correct answers, it then can detect a learning deficiency. If errors result from ineffective learning or a learning difficulty, it is necessary to furnish the teacher with remedial instruction and additional opportunities. Remedial instruction plus extra corrective opportunities enable the teacher to hypothesize why an error occurs and how to apply the learned information to clear that mistake. In contrast, when specific guidelines for error correction are not provided or additional corrective opportunities are not available, teachers find no way to try out the previous learning in discovering the correct answer. If this is the case, teachers may only process the learning content to a very shallow degree and have trouble in correcting any of their errors.

More Responding Opportunities in Help Context. Corrective opportunities should be included while teachers are using on-line help. Most courseware offers help options at the user's request or upon receiving an incorrect response. The information involved in on-line help can range from a simple error message to a complete set of instructional materials. However, as Sellen and Nicol (1990) point out, most users avoid using help. Several reasons are suggested for this problem, such as difficulty in locating information, failure in searching relevant information, difficulty in going back and forth between the help and working context, and quality and complexity problems of the help structure.

Generally, it would be very difficult for any courseware to overcome all the above weakness in on-line help unless the courseware could predict when and why help is requested. One specific way to improve the quality of help messages is to provide teachers with more responding and corrective opportunities. After the courseware receives a help request, a series of query and responding opportunities should be provided to better determine and locate the most relevant information for resolving problems.

Summary

Systematic design of computer software for learning or instruction should be used for facilitating school teachers' computer skills. Well-designed courseware can accommodate the instruction to the individual teacher's learning characteristics. Yet, many teachers have difficulties in using some courseware that is regarded as effective by programmers. This problem occurs because the courseware was designed based on programmers' point of view rather than perspectives of teachers. Possible solutions include the provision of more corrective, responding, and practice opportunities after errors. Additional corrective opportunities should be offered not only for interacting with the courseware, but for improving the effectiveness of all the instructional events. The importance of incorporating more query and responding opportunities within the on-line help context is also stressed. The provision of relevant materials plus sufficient opportunities for enhancing desired skills results in better learning.for school teachers.

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A Courseware Design Model Focussed on Students, Teachers, and Their Curriculum

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Abstract

A lack of software that is well aligned with the curriculum is a substantial barrier to teachers' use of computers in the classroom. A model of software development that provides a sound environment for student learning while allowing teachers to team with instructional designers to specify format and content is needed to overcome this problem. This paper proposes an affordable, innovative model for creating such software-based environments.

Software and Curriculum

A well-known barrier to educational technology use in the classroom is the lack of sufficient hardware or the lack of access to existing hardware to ensure continuous and sustained use by students. Although it seems obvious that an adequate supply of computer stations would remove this barrier, research evidence exists to show that student use of computers for learning will not necessarily increase even if more computers are available.

Becker (1990) conducted studies for the Center for the Social Organization of Schools that show that the computers that are currently available are used only one-quarter of the time for instructional purposes. He concludes that the teacher's focus for computer use is on teaching students how to use software. For example, high school English teachers regularly use computers in their classrooms but spend the most time teaching students to use word processing programs, while "lessons related to composing and expressing ideas in writing do not involve the use of computers."

Robbat (1985) investigated a number of barriers to technology use in the classroom. Besides a lack of access to equipment, he found that a lack of a clear set of expectations that such use would occur and a lack of software were most often cited by history teachers as barriers to computer use.

A study of teachers' selection and use of software (Carey, 1988) indicates that a primary criterion used by teachers to select software was a compatibility with curricular objectives. Thus, despite training in technology use, adequate hardware, and clear expectations that technology will be used in the classroom, such use may not occur in areas where the software is not aligned closely with curriculum.

Teachers who have training, hardware, and administrative mandates face an added barrier to technology use in the classroom: a lack of software that directly addresses the objectives and content of their curriculum. They have three options: (1) avoid using technology for those curriculum units for which no compatible software can be found; (2) use software that is marginally related to the lesson content and take extra time to supplement the unit; or (3) use generic application programs such as word processors and databases to create files and content that enrich the lesson. In the latter case, a substantial time commitment is involved as the teacher conducts research, designs the lesson's technology augmentation, enters the information, and schedules the equipment for student use.

Customizing Software

An ideal solution to the problem of matching software to curricular objectives is to customize software for each classroom or school district curriculum. The traditional model of commercial software production is clearly not designed to accommodate customization. An English teacher teaching a literature unit on a particular title such as *The Scarlet Letter* might scan catalogs to see if software has been designed to accompany the unit. If not, the teacher might turn to word processing to have students write book reports or essays on the novel. The best alternative would be to have the teacher team up with an instructional designer who can translate the teacher's curricular objectives on theme, character development, and moral dilemmas in literature into a relevant software package.

A new concept for software design and development is needed to meet these objectives and implement a process whereby the classroom teacher is in control of the curricular content of software. This process seems difficult and expensive unless some type of program shell can be developed, appropriate to each discipline, that utilizes generic methods and allows for the entry of curricular content. Learning Systems Consultants, Inc. (LSCI) of Colorado Springs is currently implementing this method, creating program shells that include: (1) a simple, user-friendly student environment that allows software utilization without significant overhead for learning the system; (2) tools for student use that are embedded into the program and do not require access from outside the program; (3) provisions for simple and easy access to external devices such as videodisc or CD-ROM; (4) a set of simple and easy-to-use tools that allow the teacher to make changes or minor content revisions; and (5) a system for embedding third party software that already meets some of the curricular objectives identified.

For example, an English teacher might outline curricular objectives for the study of mythology. The consultant assists the teacher in finding an appropriate videodisc, then builds the study of theme and character into the software. The software is designed to access videodisc segments, and also includes tools such as a dictionary, a notebook for keeping student notes, a collection of clip art for illustrating students' stories, a writer's guide that helps students with grammar and style questions, and a management system that allows the teacher to provide direct feedback to students on disk.

An environment for elementary mathematics might include such tools as a geoboard for geometry, a set of dice and coins for probability, a calculator, a box of colored shapes, and a set of cuisenaire rods. The teacher can select the problem sets that address the curricular unit to be covered, and the software allows the student to manipulate the items from the tool box in an interactive environment. Again, the environment can be augmented by a management system that allows the teacher to closely examine the student's progress through the steps of a solution, allowing for a variety of problem solving strategies and solutions. The teacher has a medium for providing feedback and encouragement for each student. A further feature that encourages the articulation of theories and findings is the possibility of including a network for student interaction with other students and groups.

LSCI has also investigated the possibility of creating multidisciplinary environments, based on a theme or problem that supports study in two or more traditional subject areas. School reform efforts and extended periods support the application of skills and knowledge across disciplines. An environment that provides portability of student work across time and space supports interdisciplinary efforts that would be difficult or impossible to manage within the traditional school structure. Students can plan presentations, produce visuals, write papers, develop video segments, and conduct debates with other students who are in remote locations or who visit the computer classroom at another time. Furthermore, student work can be preserved for future years and be augmented by other students' research and contributions.

The cost of such customization would be prohibitive without these conditions: (1) the consultant maintains program shells, generic tools, and teacher tools for each discipline; (2) the school or school district pays for the customization service rather than the product; (3) the teacher works closely with the consultant and designers to ensure a close fit with curricular objectives; and (4) the school or district is licensed to copy and distribute the software among students and/or school buildings.

Some Considerations

School district budgets can rarely accommodate the expense of multiple copies of software packages. The proposed model does not purport to remove the expense of software production and distribution, but it does ensure a higher likelihood of use by teachers who participate in its design. The model provides for teacher training when needed, follow-up services to adjust and revise software to meet the needs of students and teachers, and an opportunity to recover costs by reducing the need for multiple copies of paper products such as textbooks and student workbooks.

Some teachers will seek to further customize their software independently. For example, a teacher may utilize a customized environment for studying a particular Shakespearean play and the software meets the needs of that teacher and her students for a number of semesters or years. After attending a workshop on teaching literature, the teacher decides to use a strategy of comparing Shakespearean plays to modern plays that have similar themes and parallel developments. The teacher decides to apply the Shakespearean design template to a modern play, then adds a component that motivates students to compare and contrast the modern play and the Shakespearean play. The addition of this component should be possible with user-friendly design tools that allow the teacher independent, creative input.

Customized environments that provide easy access to technological tools and relevant materials allow the student to focus on the subject matter, processes, and learning rather than on the technology itself. One "at-risk" student user provided feedback on the concept that no systematic and objective evaluation instrument could have provided when she said, "This computer makes me feel smart."

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A Descriptive Tool for Designing, Evaluating, and Studying Computer-based Instruction

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Abstract

This paper discusses a tool that describes instructional systems in terms of their ability to manipulate information to facilitate learning. It provides us with a picture of the instructional qualities of the system. Such a tool will allow us to do research on instructional systems without reference to media or theory. It will also provide valuable information for formative and summative evaluations. The results of a preliminary use of the descriptive tool are reported and discussed.

Introduction

In a recent article Krendl and Williams (1990) reviewed research on the *Writing to Read* program from IBM. The authors found several flaws in the research used to demonstrate the effectiveness of the program. They point out that most of the research showing the effectiveness of the program ignores the fact that *Writing to Read* is supplementary to the regular reading program and therefore students using it receive more instruction. This increase in instruction is likely to account for much of the increased gain for the students using *Writing to Read*. Another claim for the program was that it provided individualized instruction. Others (Ohanian, 1984) pointed out that the program was only individualized in pacing. All students are given the same material in the same order regardless of ability or readiness. This example points out a serious problem that we face in designing and evaluating instructional systems in general and computer-based systems in particular.

Researchers are constantly comparing one instructional system with another. Computer-based systems are being compared with traditional systems. However, these studies seldom provide help in improving instruction because they do not tell us much about the system itself. Media comparison studies have not yielded much fruitful information as to which medium is better (Heinich, Molenda, & Russell, 1989). Instead, they indicate that it is not the medium that is important but rather the instructional treatment. Clark explains that what we learn from media comparison studies is that "it is the method of instruction that leads more directly and powerfully to learning [and that] when we begin to separate method from medium we may begin to explain more significant amounts of learning variance" (1983, p. 149).

The computer like other media is merely a tool and is only as valuable as the craftman's skill, knowledge, and commitment to quality allow it to be (Hannafin & Peck, 1988). The medium should not be confused with the method. Much of our research and evaluations do just that as the research on *Writing to Read* points out (Krendl & Williams, 1990). We have too frequently been pursuing a misguided horse-race mentality in research. We need tools to make our research more effective.

Another problem that we face is the poor quality of courseware. Venezky and Odin (1991), in citing causes for the insignificant impact computers have had in schools, place "lousy instructional software" (p. 30) on the list. Although there has been an improvement in courseware over the years, the situation could be much better. Hannafin and Peck warn that "the quantity and quality of educational software must improve if computers are to have a meaningful, positive impact on education." (1988, pp. v, vi). Alessi and Trollip (1991) state that a lack of skilled courseware developers is a major cause of poor quality courseware.

To address the problems of ineffective research and poor quality courseware we need a tool that describes an instructional system independently of the medium used and that concentrates on the instructional characteristics of the system. Such a tool will make comparing systems and methods a more useful and viable activity for research. It would also make it easier to determine the generalizability of the results of research on different instructional systems. We would no longer refer to traditional versus computer-based instruction but rather to characteristics or strengths of manipulative power and instructional methods.

Such a tool would help us improve the quality of courseware in two ways. First, it would provide an effective tool for formative evaluation of courseware. This use would help designers see clearly what they have created and help catch many problems at an early stage. Second, it would give the consumer a powerful tool for obtaining information for evaluating courseware. With this information the consumer could see past the producer's claims and make better judgments about what courseware to buy, thereby putting pressure on producers to improve the quality of their products.

This article describes a tool that is composed of a taxonomy and language for description of instructional systems that would allow the designer, the researcher, and the consumer to design, study, or evaluate an instructional system independently of medium and other confounding factors.

The remainder of the article is divided into four sections. The first is an explanation of the tool. The second reports the results of using the taxonomy and language to describe different instructional systems. The next section discusses the implications and value of using such a tool in computer-based instruction. The final section presents conclusions and recommendations.

Explanation of the Tool

The tool consists of:

- terminology for describing instruction
- terminology to describe instructional interactivity
- a method of mapping instructional interactivity

The emphasis in the taxonomy is on the instructional system's ability to manipulate information to meet the needs of the individual student. I will explain each of the components in the above order.

Terminology for Describing Instruction

It is important to be able to describe the structure of the teaching activity. The terminology used should be atheoretical to describe instruction created using different theories. I have used Merrill's (1983) presentation forms for part of this job. Although the presentation forms are part of Merrill's component display theory, they do not represent a theory themselves but rather a language that can be used to describe any method of instruction (Reigeluth, 1983). For the other part I have used Gagné's (1985) events of instruction with adaptations in events 3-6 based on Rosenshine and Stevens (1985), Anderson, Hiebert, Scott, and Wilkinson (1985), Baumann (1984, 1986), Good and Grouws (1979), and Mason, Roehler, and Duffy (1984). I have taken the similarities among these authors and adapted Gagné's events of learning to reflect the similarities (Hoskisson, 1989). While these events of instruction are not truly atheoretical, they approach it because they are drawn from several different perspectives and from different sources and still maintain a strong unity.

Merrill's taxonomies.

Merrill's taxonomies consist of a set of primary and secondary presentation forms. "Presentation" is Merrill's term for an instructional activity. The primary presentation form (PPF) taxonomy is based on the belief that all cognitive activities can be classified according to two dimensions.

The first dimension is the level of specificity of the subject matter. The subject matter can be presented on a general or a particular level. A presentation on a general level is called a generality and one on a particular level is called an instance. A generality is a statement of the definition of a concept, a list of steps involved for a procedure, and the general laws that apply to a principle. There is no generality for a fact. An instance is a particular case of a concept, procedure, or principle. All facts are instances (Merrill, 1983).

The other dimension refers to the type of response that is expected from the students. A generality or an instance can be presented in an expository way; for example, telling, illustrating, or modeling to which the student does not give any overt response. They can also be presented in an inquisitory manner that requires an overt response from the students (Merrill, 1983). Thus the primary presentation forms (PPF) are:

- expository generalities—EG
- expository instances—Eeg

- inquisitory generalities—IG
- inquisitory instances—Ieg

For example, telling a student that the "s" and "h" together make the consonant digraph "shh" is an expository generality or EG. Using the word "shirt" to illustrate the sound is an expository instance or Eeg. Asking the student what sound the "s" and "h" make when together is an inquisitory generality or IG. Asking the student what sound the "s" and "h" make in "shirt" is an inquisitory instance or Ieg.

PPFs are the main blocks of instruction. For instruction to be complete, though, Merrill has developed a second level of presentations called Secondary Presentation Forms (SPF). These forms are elaborations on the PPFs. The elaborations put the new information in context, recall prerequisite learning, provide mnemonics, provide mathemagenic help, present the information in alternative representations, and provide feedback. Figure 1 shows an adaptation of Merrill in which a category for analogy/metaphor is added (Hoskisson, 1991). I have added that category because of the value of analogies and metaphors in establishing a connection between new and old information (West, Farmer, & Wolff, 1991).

Gagné's Events of Instruction.

Gagné postulated nine events of instruction (each event is followed by the abbreviation used in the analysis):

- Gaining attention. GA
- Informing the learner of the objective. ILO
- Connecting the new learning to prior learning. CNT
- Presenting the stimulus material. PSM
- Guided practice. GP
- Independent practice. IP
- Provide feedback. FB
- Assessing the performance. AP
- Enhancing retention and transfer. ERT

These events are not intended to be linear and inflexible. It may be necessary to repeat events four through six to ensure learning. Neither is every event required for

Secondary Presentation Forms

Primary Presentation Forms	Feedback (FB) (ca) correct answer (h) help (u) use	Representation (r)	Mathemagenic Help (h)	Mnemonic (mn)	Prerequisite (p)	Context (c)	Analogy/Metaphor (a)
EG		EG'r	EG'h	EG'mn	EG'p	EG'c	EG'a
Eeg		Eeg'r	Eeg'h	Eeg' mn	Eeg'p	Eeg'c	
Ieg	FB'ca FB'h Fb'u	Ieg'r	Ieg'h			Ieg'c	
IG	FB'ca FB'h Fb'u	IG'r	IG'h			IG'c	IG'a

Figure 1. Secondary presentation forms.

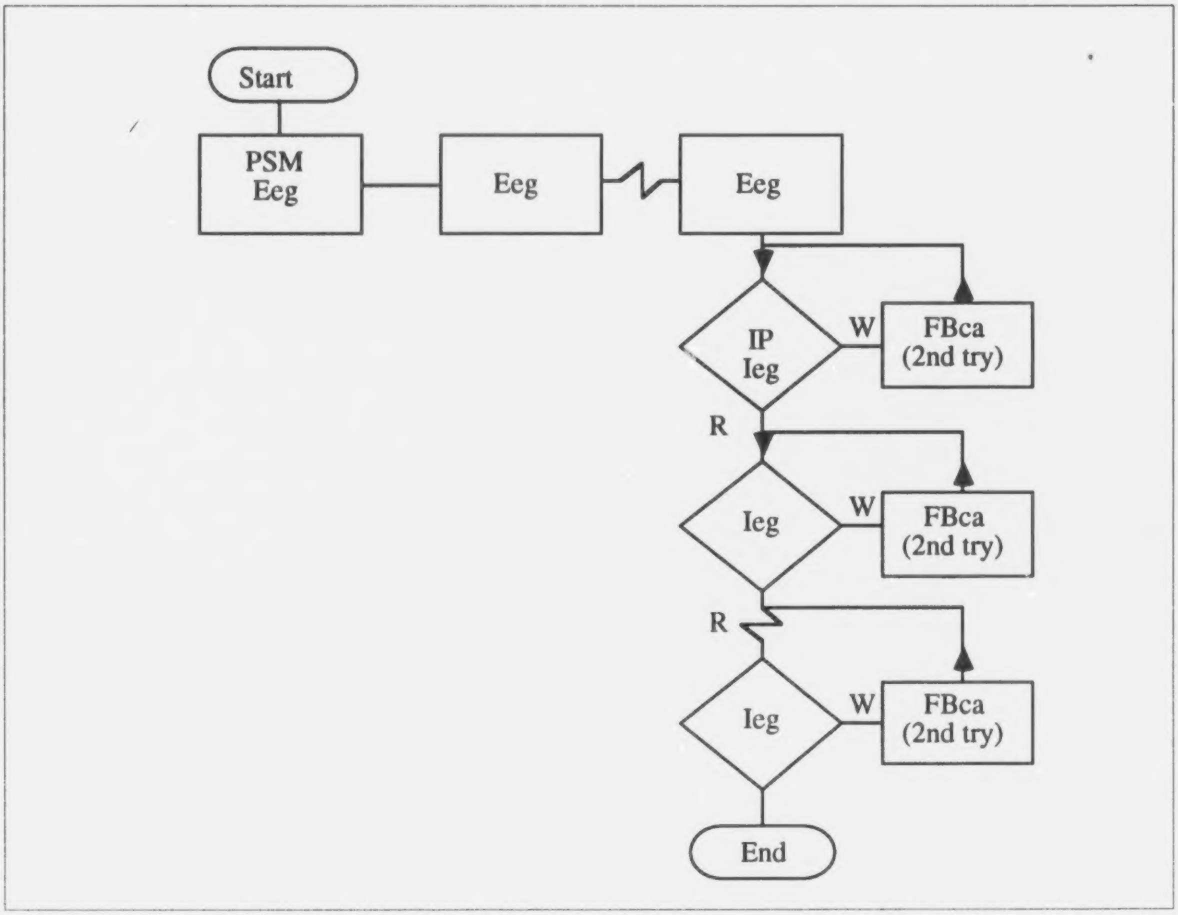

Figure 2. Instructional activity map for a level III interactive videodisc.

every piece of instruction. They do, however, give the designer or evaluator a way of describing the elements of instruction.

Terminology to Describe Instructional Interactivity

Another aspect of an instructional system is how it responds to student input. This area includes four variables: number of attempts allowed in responding to a question, whether it is linear or branching, error diagnosis routines, and audio/visual capabilities. The first variable is straightforward. How many times is the student allowed to attempt an answer to a given question? For the second variable, a program is linear if it follows the same path each time and with each student. If the program follows different paths according to varying student input then it is branching.

The third variable has five parts. First, does the system provide the correct answer? Second, if more than one attempt to answer is allowed, does the student encounter a new question or the same one? Third, if the student is recycled through more instruction after making an error, is it the same instruction or new material? Fourth, are hints and/or clues given to help the student correct an error? Finally, can the system can respond to specific learner errors or does it makes the same decisions for all errors?

The last variable deals with visual and auditory aspects. Are there still, live motion, or animated images? Is there sound? Do the images and sound carry part of the instructional message or are they decoration?

Method of Mapping Instructional Interactivity

This method is similar to flow charts except that it shows instructional logic as opposed to programming logic. I will discuss this in more detail in the results section.

Results

I have used the descriptive tool for the analysis of five different instructional systems. I examined a selection from a basal reader for the third grade (Castles of Sand, 1989), a computer-based instructional game about the constitution (*Preserve, Protect & Defend*, 1987), a college level tutorial in human anatomy (*Ralph*, 1991), a level III videodisc application for teaching sign language (*Introduction to Sign Language*, 1991). I chose these example programs because they represent a broad spectrum of computer-based instructional systems. I included the print-based system for comparison purposes. The computer-based systems claimed a high degree of interactivity. It is illuminating to compare their interactivity with that of the basal reader.

Figure 2 is an example of what an instructional activity map looks like.

This map is a visual description of the instruction. The map makes it easy to compare the instructional skeleton of one program to another. The triangle shapes represent a question for the learner. The rectangle shapes are expository sections where no instructional response is required from the learner. The labels refer to the events of instruction and the presentation forms. The arrows indicate directions. The zig-zag lines indicate a repetition of the same pattern. The analysis shows that the interaction between the program and learner consists of presenting information, a question, and student response followed by feedback with the correct answer and no attempt made to individualize the program's response to learner input. This same pattern is followed in all the programs reviewed.

Discussion

One value of the analysis is that it lets us compare the specific portions of the programs where there is interaction between the learner and the system. If we look at just that part of each program we see a similar pattern among them. Figure 3 shows their basic pattern.

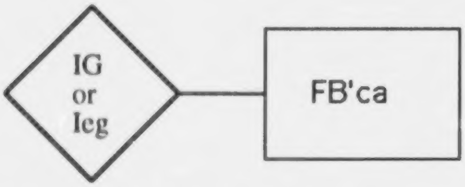

Figure 3. Basic instructional activity pattern.

The learner is asked a question and given 1 to 4 chances to answer the question. When the student chooses the correct answer or has used all the chances, the system confirms or reveals the correct answer. This pattern does not vary to accommodate individual learner responses.

Despite the claims of interactivity by the computer-based systems it is difficult to tell the difference between them and the basal reader when looking at the instructional interaction. They all provide the same feedback of revealing the correct answer. None of them individualizes the instruction. They are all linear. None of them is significantly interactive. They all lacked error diagnosis capabilities. Sound is not used for any instructional purposes. Only one of them offers any clues. They offer no remediation. The only advantage that the videodisc program offers is the use of motion. However this may not be more effective than some other method of conveying the same information. Clark (1983) points out that the positive effects of adding motion (specifically zooming) can also be achieved by a series of still pictures.

This analysis shows clearly the manipulative power of an instructional system. We can easily see that the interactive computer-based and videodisc programs were no more interactive than the basal reader.

Conclusions and Recommendations

The purpose of this paper is to describe a descriptive tool for use in designing, studying, and evaluating computer-based instructional systems. This tool would help us solve two problems: ineffective research and poor quality courseware. The sample analyses have shown that the tool is effective in giving us a clear picture of the instructional qualities of a given system. This can help improve the quality of research by helping us ignore questions such as media and concentrate on the instructional aspects of any system. Using this tool would help researchers avoid some of the confounding factors in research pointed out by Krendl and Williams (1990) and Clark (1983). The component of the tool that showed the error diagnosing ability of the system would indicate whether the system was capable of individualizing the instruction. By helping the researcher avoid such problems, this descriptive tool would help improve the quality of the research and make comparison studies more valid.

The sample analyses also show that the tool is useful for formative and summative evaluation efforts. By using the taxonomies and language to describe the program, the designer can detect instructional shortcomings during the design stage. The concept treatment map was an effective aid in the formative evaluation of the humanities program. It pointed out some serious problems that were more easily corrected during the design stage than after the program had been produced. If the producers of the level III videodisc program had used the descriptive analysis they would have seen that they had not achieved a significant interactive quality in their program.

Limitations

The results of this initial analysis reveal important limitations. The tool does not include the needs of specific types of programs. There are many elements of a good instructional game that are not addressed. One important element not addressed is the appeal of the environment or setting of the game. Another issue is the appropriate use of luck or chance. For all types of programs aspects that are subject matter related are not considered either. Aesthetic appeal, creative quality, and motivational elements are not addressed. The issue of ease of use is not included. The analysis does include the essential element of instructional interaction but that is not sufficient for evaluation purposes.

This initial test shows that the system needs further refinement. The events of instruction and the presentation forms need to be more effectively merged in the description. Further needed refinements will become evident as the tool is used more.

Future Developments

There are several other components that would be useful for this type of descriptive tool. One important one would be an objective classification component. If we are going to compare systems then we need to be sure they are dealing with the same objectives. We also need to look at the type of program. Games cannot be compared to tutorials.

It would be helpful to be able to assign a numerical value to a measurement of interactivity or dynamic quality of an instructional system. This component is in a preliminary stage at this time. I am developing a method for giving a numeric value to the dynamic quality of a program. A dynamic system is one that can change its functioning according to learner input. It does not require an external agent to make changes. The interactive agent is an internal one. A static system is one that cannot change itself. An outside agent must make any changes in the system to accommodate the student. The interactive agent is an external one. The basal reader is an example of a static system. Much of the information for this measurement is already developed in the analysis process. The next step is to quantify it.

An additional component would be one for complexity. The intent of this component will be to give some idea of how complex a system is. A simple system is one that has only one component and performs only one function or has multiple units that each only performs one function and one unit does not influence another. A complex system is one that may have only one unit but that unit performs many functions or it may have multiple units each performing one or more functions and the output of one influences the function of one or more others.

Eventually this component will be linked to the measurement of the dynamic quality of a system to form a matrix with simple to complex on one axis and static to dynamic on the other axis. Most instructional systems in schools are static and many are simple. A simple static system such as that found in a typical textbook has no power to manipulate information, it can only present information in exactly the same form each time it is used no matter who is using it or what questions they may have. A complex dynamic system has strong manipulative powers and can change the presentation according to learner input.

Other future developments will need to address the limitations discussed earlier. There is definitely a need for a component that could describe the creative, motivational, and aesthetic qualities of a system. Even if a system meets all our other criteria, if it doesn't appeal to the learn it will be of little or no value.

Summary

This initial use of the descriptive tool shows promise as an effective tool in helping to address the problem of ineffective research and poor quality courseware. However, there are still many refinements that need to be made. It needs to be used by more people on more instructional systems to develop it to a greater level of value.

For a more complete report and explanation please contact the author.

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Storyboarding: A Creative Technique for Planning Technology Use in Education

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Abstract

Storyboarding utilizes both creative and critical thinking in a visual display to facilitate program planning. *Storyboarding V1.0,* an interactive hypermedia software package, teaches this effective technique in a nonlinear heterogeneous program designed to provide interactive experiences for the learner.

Storyboarding is an effective planning technique that requires active involvement of all members of a small, carefully selected team in using both creative thinking and critical thinking to develop a clear plan for solving a problem, planning a program, or creating a product. This technique has been used for a number of years by such organizations as IBM, McDonald's, Disneyland, Pizza Hut, and AT&T for planning new products and services. With the increased use of technology in teaching and teacher education, it seems that storyboarding would be an apt tool for ensuring the wise use of technology in education programs and in the development of software for teaching. *Storyboarding V1.0* is the subject of an innovative interactive hypermedia technique to classroom teachers and school staff personnel.

Historical Background

Storyboarding in it simplest form was used by Leonardo Da Vinci who was known to have affixed his unfinished work to a wall in order to study it (Lottier, 1986). Walt Disney is said to have remembered this technique of Da Vinci's and to have applied it to the organization of the thousands of cartoon drawings required to achieve "complete animation" in his feature films (Vance, 1982). By posting their drawings on the wall in sequence, Disney and other artists could watch the cartoon's storyline develop.

In the 1960's a member of the Disney organization, Mike Vance (1982) and Jerry McNellis, a creative planning specialists in New Brighton. Pennsylvania (Lottier, 1986), introduced the concept of storyboarding to the business world as a technique for organizational planning.

Definition and Description of Storyboarding

Storyboarding is a planning technique that requires active involvement of both hemispheres of the brain—the right hemisphere for its creativity, and the left for its critical thinking ability. Because of its high level of use of both hemispheres of the brain, McNellis has referred to the technique as "pure form thinking" (Lottier, 1986, p. 421). Every story board begins with a problem that needs to be solved or a need that must be addressed. For example, a school-based team may develop a story board to decide what kinds of technology will best meet the instructional needs of its institution, and may develop a comprehensive plan for acquiring the necessary equipment and software and for implementing its use.

Once the need for the storyboarding process has been determined, a Project Team will be assembled. The ideal team will consist of 6 to 8 members who represent different areas of interest in the problem at hand. For example, to solve a problem about the institution's education technology program, there should be a member with expertise in the content areas for which the program is being designed, one who is knowledgeable in instructional design, one with knowledge of production capabilities, and perhaps one with a background in the visual arts (Johnson, Widerquist, Birdsell, & Miller, 1985). The team will also need a *sanctioner*, a person with the authority to approve the project and give permission for the solution or final product to be implemented (Vance, 1982). (The sanctioner need not be an actively participating team member.) One team member will serve as *project leader* to ensure that the team meets on schedule and to monitor the team's progress.

The initial meeting of the team is a creative thinking session—a "sophisticated form of brainstorming" (Barr, 1988). The team's *facilitator* will keep ideas flowing by asking leading questions that will cause the team members to view the well-defined question from many different angles. The facilitator also ensures that there will be no "killer statements"—critical (negative) comments that are NOT allowed during the creative thinking session (Hoover, 1980; Vance, 1982).

As the brainstorming session proceeds, ideas are jotted down on index cards and pinned to a large board (or wall). Specific members of the team may be designated as *writers* and *pinners* to enable the verbally stated ideas to be presented quickly in a visual manner. The object of the entire creative thinking session is to generate as many ideas as possible, no matter how strange some of them may seem.

The configuration of the storyboard is designed to enable the Project Team to see interrelationships among ideas, to rearrange the ideas for clarity, and to "hitchhike" on ideas already presented (Hoover, 1980; Lottier, 1986; Vance, 1982). The problem statement is written on a 5"x8" index card and placed at the top of the board. Beneath it are placed the *headers*, 4"x6" index cards containing the major categories or subdivisions of the main topic; ideas for accomplishing or solving each of the header topics are jotted down on 3x5 index cards are pinned under the appropriate header. As the session progresses, new headers may be added and cards may be moved about as new categories develop. It should be noted that there are two headers required for every story board: *Purpose* and *Miscellaneous* (Vance, 1982). These headers ensure that the purpose for the project is kept firmly in mind, and that there will be a place for those ideas that don't deem to fit under any other existing header.

Following the session for creative, free-wheeling production of ideas, the team should take a break in order to "shift mental gears" from right to left brain before embarking upon the left-brain critical thinking session (Lottier, 1986). During the critical thinking session, each idea produced during the brainstorming session will be scrutinized in order to determine its viability. The conclusion for the critical thinking phase of planning will find the number of cards on the initial story board pared down to a manageable few. Ideas may have been combined, rearranged, or discarded, but what remains will be the basis for a workable plan for solving the problem that the team initially set out to address. The resulting story board is called the "Planning Board" (Vance, 1982).

Once the Planning Board is complete, the Project Team must develop a timeline for implementation of the plan, and must determine who will be responsible for the completion of each task. The Team will also decide what communication, if any, will need to be done. For example, who needs to know about the plan? How will they be informed? If the final plan is sufficiently complex, it may warrant the development of further story boards—the Ideas Board that uses current headers as topic cards with their subbers as Ideas Board headers; the Communication Board to determine how the plan will be publicized; and the Organization Board that will assign task responsibilities and create the timeline for accomplishing the various tasks that the Planning Board has generated (Vance, 1982).

Benefits of Storyboarding

The benefits of the storyboarding approach to program planning or problem-solving within an organization are numerous. It requires the active participation of members who represent an array of interests in the program as well as a variety of learning styles and a variety of skills. It generates a much larger number of creative ideas from which to choose, and those ideas are representative of most if not all of the organization or institution. As Johnson et al. (1985) point out, "Group storyboarding acts as a funnel through which these various interests pass and blend into a whole representative of the component expertise" (p. 30).

The process enables members of the organization to understand and visualize the solution readily. "It is easier for most people to understand any kind of information if clear visuals supplement the verbal message" (Barkman, 1985). Finally, storyboarding generates a high level of enthusiasm for solving the problem or for planning and implementing the new program (Vance, 1982).

The need for an effective planning process for making education programming decisions combined with the demonstrated efficacy of the storyboarding process led to the development of an innovative interactive hypermedia software package for teaching the storyboarding technique to teachers, educational administrators, institutional staff members, and teacher trainers.

Storyboarding: The Hypermedia Software Package

The demonstrated success of storyboarding as a planning process for institutions and organizations coupled with the need for such an effective planning process in the field of education in general and instructional technology in particular leads to the notion that knowledge of this successful technique should be made available to members of the education profession. Workshops at professional conferences and coursework for preservice and inservice teachers have been helpful in disseminating this information, but reach only a few of those professionals who could utilize the storyboarding process. In addition, workshops and class presentation rarely provide the practice necessary to learn the process well.

These differences in disseminating the necessary information could be overcome by the development of an interactive computer software package that could be programmed to provide not only the requisite information, but interactive experience with the process as well.

In order to accomplish this task, an interactive *HyperCard* stack, *Storyboarding V1.0* was developed. Interaction was achieved in several ways to engage the learner actively with the task of learning the storyboarding process. For example, the intro-system to the stack is interactive, permitting the learner who may not be comfortable with the computer to learn how to use the stack. At any point during the program the learner may ask for help in using *Storyboarding V1.0* and receive help by choosing from a series of questions and answers.

Since the authors desired not only to teach basic information but to provide interactive experiences as well, *Storyboarding V1.0* was developed as a nonlinear heterogeneous program for storyboarding and its various components. The learner may start the program at any point in the main menu, and may skip or repeat any section desired. In the sections that describe the actual storyboarding procedures, learners receive actual practice in designing their own storyboard by creating their own headers and subbers.

Provision is made for the learner to gain information about all four types of storyboards, including the Ideas, Communication, and Organization Boards as well as the Planning Board if the learner so desires. Visual aids include diagrams of storyboards and a cartoon character who serves to personalize the instruction. Occasional sound effects add interest.

Storyboarding V1.0 is working well for adult learners including preservice teachers. However, many teachers expressed the desire to teach storyboarding to their students, and found that *Storyboarding V1.0* is too sophisticated for upper elementary and some secondary students who could benefit from use of the storyboarding process in planning their own projects. The authors are now in the process of developing *Storyboarding V2.0—MacMan's Greatest Challenge*, an interactive ^stack more appropriate for use by children. *Storyboarding V2.0 — MacMan's Greatest Challenge* should be completed during the spring of 1992.

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Supercomputing and the Science Teacher: A State of the Art Challenge

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Abstract

Over the past five years, supercomputers and the high speed networks that connect them have had a profound impact on the way science is done at the research university. This impact has extended into the undergraduate curriculum and, through the *SuperQuest* program and other efforts, is now being felt at the secondary school level. This paper will identify the critical issues for science teacher education and propose strategies for fully realizing the benefits of supercomputing technologies. In particular, we will (1) examine why supercomputing technologies have a role to play in secondary school science, (2) identify the major obstacles that prevent science teachers from effectively incorporating computational science and its tools into the secondary school curriculum, (3) suggest some ways in which these obstacles can be overcome, and (4) propose some broad strategies for advancing the widespread use of computational tools.

Introduction

Supercomputers are often described by the simple definition of "the fastest computer available at any given time." However, the sheer processor speed of a computer is inadequate to describe the full range of high performance computing tools and technologies that have had such a profound impact on science over the past five years. Researchers have taken the raw computational speed of single processors and used them in parallel to attack many of the most sophisticated and complex problems facing the scientific community. These problems include forecasting severe weather storms, understanding the complexities of the molecular structure of DNA, designing aerospace vehicles, and improving the efficiency of combustion engines. The problems of air pollution have received widespread attention in the popular and scientific press and are particularly well-suited to investigation with high performance computing technologies (Office of Science, 1991).

These technologies include tools for the scientist to visualize complex, multi-dimensional data and to explore the massive amounts of data from experimental phenomena as well as computer simulation. Just as important as the tools for analysis and insight are the communications networks that allow scientists to access the resources available at the national supercomputing centers and to communicate and collaborate with colleagues all over the country. Researchers are no longer limited by their geographical location or proximity to resources. Electronic networks allow for rapid communication of new ideas, feedback and insight from colleagues, sharing of data, and dissemination of results.

Collectively, these technologies—high speed computers, application software and visualization tools, and network connectivity—have given major impetus to the development of what is now known as "computational science." The modalities of experiment and theory are well-known and understood by scientists and science educators alike. The methods of computational science, which are only now becoming well-established in graduate and undergraduate science education, bring together the mathematical techniques for expressing a model of a physical phenomenon, a computer implementation of that model, and the actual investigation of the phenomenon by varying the parameters, the data and the assumptions expressed in the model (Worlton, 1991). The mathematical methods and computer techniques can range from a simple program for a personal computer to hundreds of thousands of lines of code requiring many hours of time on the the fastest supercomputer. The applications of computational science are rapidly increasing throughout the industrial and academic communities. The challenge facing us, therefore, is how to effectively educate science teachers both in the understanding of these principles and methods and in the effective application of the new technologies. This paper will address the issues inherent in that challenge.

The Role of Computational Science

Let us take a closer look at why computational science and supercomputing technologies have a role to play in secondary science education, and review some of the programs that are currently providing opportunities for high school students and teachers. Students will increasingly encounter computational approaches to science in the undergraduate curriculum, in the industrial setting, and indeed in the understanding of critical social issues such as environmental modeling and global climate warming. Computational science and the tools of high performance computing also provide some unique opportunities for students and science teachers. Computational science brings together mathematics and computer science in the investigation of a scientific problem. Typically, the study of each of these subjects in the secondary school setting is distinct from the other. The problems taught in a typical "computer programming" class seldom incorporate any of the ideas of, for example, random number generation or linear algebra. Nor do they look at problems from the physics curriculum, for example, in the study of motion or gravitational fields. Conversely, typical science textbooks in chemistry, physics and biology do not include any laboratory experiments or problem solving exercises that make use of computer models. Computational science and its tools provide an opportunity to integrate science with mathematics and computer science, while investigating multidisciplinary problems.

Involving students in the active investigation of real scientific problems can dramatically change the activities in the classroom from hearing about science to actual participation in scientific activity. Early experience with the SuperQuest program (described below) indicates that high school students have both the talent and the interest to investigate science problems using not only personal computers, but supercomputers as well. Student projects have included the study of chaotic cardiac arrhythmias, the optimization of traffic light cycles, an investigation of visual patterns in prime numbers, and an analysis of water pollution in a local river. Problems such as these suggest that by approaching problems computationally, students can investigate scientific problems that are realistic and of high interest, and provide motivation to the students and teachers alike.

Tools for scientific visualization are among the most effective means of bringing real science into the high school classroom. Research scientists are increasingly using such tools both to communicate the results of their work to colleagues and to gain insight into the scientific phenomena they are exploring. The widespread use of the image tools developed by the National Center for Supercomputing Applications attest to the power of visualization for scientific understanding. Visualization can provide insight into simple spatial relationships of three-dimensional objects, as well as complex, multivariate data sets that vary over time. The enthusiasm and excitement of students and teachers exposed to high end graphics workstations suggests that these tools can have a tremendous motivational impact as well.

The national networks provide a channel for scientists at research centers throughout the country to collaborate and communicate on their scientific work. These networks are readily available to members of the higher education community and are now being extended to the K-12 school system. State efforts in Texas, California, Iowa, and elsewhere, have provided access to the internet to high schools throughout these states. In addition to providing access to the numerous informational resources and the computing resources on the network, this connectivity can also provide a valuable opportunity for teachers and students to communicate with colleagues as well as with mentors and scientific experts.

Early Experiences with High Schools

Several programs at both the state and the national level have brought the technologies of high performance computing—the high speed computers, applications software and visualization tools, and the networks—and the methods of computational science—the mathematical models, the computer applications, and the investigation by running the model—to high school students and their teachers. We will briefly review three of these programs: the Cornell Theory Center's SuperQuest Program, the

New Mexico Supercomputing Challenge, and the University of Alabama's program for curriculum development and teacher training. The first program is national in scope and the second two are focused at the state level. The SuperQuest program is competitive and selective; the other two programs are broad-based in their participation, involving students and teachers from a full range of educational settings.

SuperQuest is a national competition designed to encourage and involve high school students in pursuing computational science projects, and to stimulate the integration of computational science and its tools into the high school curriculum. The competition is based on independent or team student projects, under the guidance of a teacher-coach. Winning teams are invited to spend three weeks for intensive training at a SuperQuest supercomputing center (the Cornell Theory Center, the National Center for Supercomputing Applications, or the University of Alabama in Huntsville/Alabama Supercomputer Network). The winning high school of each team receives a network connection to the supercomputing center and full support services so that the students can continue their project research during the school year. Each student has the opportunity to work with a scientific mentor while at the center and to continue communications using the network.

The New Mexico Supercomputing Challenge is an academic year-long program in which teams of high school students and a sponsoring teacher work on computational science projects using high performance computing. The teams are assisted in their efforts by a technical coach from the staff of Los Alamos National Laboratory. Each team is provided network access from their local school to the supercomputer center. The overall goal of the Challenge is to increase science and computing knowledge at the high school level by exposing large numbers of students and teachers to computational science. The teams compete for individual awards, scholarships, and computer equipment for their schools. The unique characteristic of the Challenge, now in its second year, is the open and nonselective participation that it offers. "Because the Challenge is open to all students on a nonselective basis, the emphasis is on achievement, or competition at each team's own level. There is a wide variation of knowledge among the students—from students who do not know any programing language to those who have broad and diverse knowledge and experience in the use of computers" (Cohen, 1991)

The competition has had a high level of participation among New Mexico schools, nearly doubling the number of teams in the second year and reaching significant numbers of women and minorities:

	1990-91	**1991-92**
students	231	419
teachers	60	93
teams	65	112
schools	41	51

The University of Alabama program for high school teachers is now in its fourth year, providing in-service training to high school science and mathematics teachers. A teacher training manual and curriculum materials have been developed for use in the classroom. After participating in the initial training, each teacher is provided network access to the supercomputer over the Alabama Supercomputer Network. Two follow-up sessions are provided to the teachers in the spring and the fall of each year. Students can use the supercomputer either in independent study projects or for classroom assignments. The Alabama program has shown that students who had previously voiced no interest in continuing their education beyond high school completed a course in supercomputing with a strong desire to pursue a scientific career (Carruth, 1990).

These programs suggest that both teachers and students can benefit from access to the tools of high-performance computing and from participation in the larger scientific community. Despite these program efforts, and the widespread belief that science and mathematics education in the U.S. is currently inadequate to meet the challenges of economic competitiveness and the need for a scientifically and technologically literate society, the use of computers in the secondary school is woefully inadequate. "Although many educators believe computing technology could help solve this problem, studies show that this technology has seldom found its way into secondary school mathematics classrooms. ... in the state of New Jersey, systemwide computer integration into mathematics instruction is at a level of less than 1%" (Friedman, 1991, p. 72). We may be able to gain some insight into this level of inadequacy by examining the process of innovation adoption and decision making.

Barriers to Implementation

The innovation-decision process model offered by Rogers can give us some understanding of the barriers to implementing computational science and its tools into the secondary school curriculum (Rogers, 1983). This model delineates five sequential stages in the process of innovation decision making: (1) knowledge occurs when an individual or organization is exposed to the innovation's existence; (2) persuasion occurs when a decision maker forms a favorable or unfavorable attitude toward the innovation; (3) decision occurs when a decision maker engages in activities that lead to a choice to adopt or reject; (4) implementation occurs when the innovation is put to use; and (5) confirmation is the reinforcement for continued or discontinued use of the innovation. Given the early stages of experience with computational approaches in the secondary school, we will consider in detail only the first two stages of this process.

Rogers describes the knowledge stage as consisting of three elements: awareness, how-to, and principles knowledge. This stage is a particularly critical one for the implementation of computational science into the high school curriculum. Perhaps the greatest difficulty is simply that most science teachers' own education was completed prior to the advent of high performance computing. This problem is compounded by the fact that school administrators are often unaware of why computational science is important for the curriculum and may fear the potential of increased costs for the long-term support of computers and networks. The University of Alabama's teacher training workshops have focused on the basic how-to's of using the supercomputer, networks, and visualization tools and on the basic principles of computational science, generally through some basic programming or applications.

At the persuasion level, Rogers characterizes the innovations under consideration by their relative advantage, compatibility, complexity, trialability, and observability. Let us examine high performance computing technologies in terms of these characteristics in order to better understand why the adoption of this technology is likely to proceed slowly. The relative advantage of computational approaches to understanding science is not widely understood by high school teachers and administrators. Neither teachers nor administrators are sufficiently aware of the need, the advantages and the potential of computational science for secondary school education. The experience of each of the programs described above indicates that students and teachers alike have a high level of enthusiasm and motivation for these new tools and technologies, once exposed to their use and application. "Just as teenagers are naturally interested in high-performance cars, giving them the chance to use high-performance computers can make a difference" (Cohen, 1991, p. 10).

Compatibility with existing courses and school support systems is also a problematic area. "Changes in lesson plans are particularly difficult when teachers are faced with rigid curricula requirements that are already difficult to implement in the allotted time, and when teachers have no models of how to effect computer integration" (Friedman, 1991, p. 72). There is a critical need for the development of curricular materials that can be integrated into existing science courses. Many of the tools that are currently being used are simply too primitive for widespread use. Existing textbooks in physics, chemistry and biology do not include computational experiments or analysis. Materials are now being developed through the University of Alabama teacher program that will include more extensive teaching materials, such as student exercises and guides.

The relative complexity of computational science and its tools is another barrier to the implementation in the secondary school science program. High performance computing is perceived as difficult to use and to understand. The experience of the SuperQuest program, and others, has shown that the availability of teacher time to learn new tools and methods is a major inhibitor for the inclusion of computational approaches into the curriculum. Classroom materials must include software tools that are easily learned and robust in the high school environment. The opportunity to study more complex scientific phenomena provides a distinct challenge in preparing teachers to teach complex systems and ideas.

A fourth characteristic of this technology that is a barrier to its acceptance into the secondary school is the difficulty with trialability. By trialability, we mean the degree to which the technology may be experimented with on a limited or trial basis. For example, one important component of high performance computing is the access to resources over the networks. Many states are currently involved in comprehensive networking solutions for the K-12 community. However, even as this infrastructure is put in place, it is unfortunately characterized by a fairly low degree of trialability. The programs reviewed above have explicitly dealt with providing network access for students and teachers. However, network connectivity is not an easy technical solution. The contrast of networking technology with FAX technology is startling in this regard: with very little technical expertise, anyone can purchase a FAX machine, order a new telephone line, and begin using the machine within hours. One has only to look at the widespread use of these machines to be convinced. A connection to the internet, however, can involve the purchase of new and unfamiliar equipment, upgrades to existing computer hardware to handle the new functionality, interacting with telephone, computer equipment and network equipment vendors, licensing fees and software acquisition, and support services. The cost of a connection to the internet, while decreasing, is still not trivial for most secondary school budgets. The trialability of computational methods is further inhibited by the lack of opportunities for teacher training and by the lack of curriculum materials.

A fifth characteristic that influences the adoption of an innovation is its observability, or visibility of use. This is perhaps the greatest value offered by the supercomputing programs described above: the proof of concept that they provide. Given the difficulties of incrementally experimenting with computational science (in large part due to the lack of appropriate materials and the lack of teacher time and training) and the difficulties in individually establishing network connectivity (a complex technology that is by its very nature difficult to experiment with), state and national programs for students and teachers provide the additional resources necessary for those "early pioneers" to take on the challenges. The visibility of these programs, and the excitement they generate among students and teachers alike, will only serve to increase awareness of the possibilities at all levels!

Overcoming the Obstacles

Several lessons have been learned from early programs bringing computational science to high school students and teachers. Any model for change must include three programmatic elements: (1) curriculum materials development, (2) teacher education, and (3) an on-going support structure. Many of the materials that have been used for teacher training in the existing programs could be refined and developed into modules for classroom use. These would need to include the critical links to existing curricular objectives, as well as appropriate student manuals and guides for teachers. Many of the student projects that have been developed could be used as classroom modules. The networks would provide an ideal mechanism for the dissemination of such materials. Connectivity to the networks would then bring with it the immediate advantage of readily usable classroom materials. To be most effective in the schools, however, such materials should use existing computational platforms (such as Macs and PCs) that are familiar to students and teachers alike. This would allow the teacher to try new technologies in ways that would be compatible with existing equipment and support structures and that would have relevance to current curricular objectives.

Adequate inservice training for teachers must include sufficient time for the teachers to become familiar with both the new tools and the new principles. Continued inservice programs, such as follow-up sessions after summer institutes, have proven effective in the Alabama teacher program. Consulting support via telephone and the networks is a necessary requirement for problem resolution as teachers begin to use new computers and the networks.

Most schools lack the networking and computer technology support that is necessary to overcome initial frustrations in using less-than-friendly software and network interfaces. Provision of support services is critical to the ongoing use of new technologies. Teachers also need to find continued support from both peers and administrative supervisors. This support must include the discussion of relevant issues and the evaluation and revision of materials. Such peer interaction will be critical to the diffusion of these new technologies. We note that the effectiveness of scientific mentors for students involved in computational science projects suggests that the relationship of the school and the teacher to the larger scientific community can be key to a successful science education program. The relationship with the larger community of science educators and professional scientists needs to become part of the institutionalized support structure of the secondary school system.

Strategies for the Future

Even with ready access to computers, a skilled and knowledgeable teacher, and the support of the school system for the integration of computational science, the task ahead is still a formidable one. Experience suggests that programs such as SuperQuest can be extremely motivational for students and teachers alike. At the same time, it is clear that for widespread use of computational tools, we must provide a comprehensive, coordinated program designed to integrate such tools into existing science and mathematics courses. Such a program must include teacher training programs and attention to the support structure necessary for the effective use of the new technologies. To the extent that networks are not particularly easy to try in an incremental way, school systems and educators at the state level will need to provide for comprehensive initiatives in this area.

At the same time, to truly extend the benefits of computational science and high performance computing into the secondary classroom, robust and user-friendly tools must be created that will allow teachers and students to develop scientific models and to investigate new questions. For the widespread use of such tools and curriculum materials, teacher training in computational methods must be provided to large numbers of science teachers. Radnor points out that change in educational practice tends to occur incrementally because practitioners do not have sufficient time or resources to initiate major changes at one time. The new materials or processes must also be integrated with existing resources and adapted to fit user constraints (McGonical, 1984).

The existing programs in supercomputing for high school students and teachers suggest a fundamental shift in the educational paradigm: teachers and students become much more actively involved in the scientific process. The experience of interacting with a broad national community of scientists and science educators and of using resources far beyond those of their own school building has proven to be beneficial to both the high school and the university or research center. Only the very first steps in building these linkages have been taken.

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OOPS: The State-of-the-Art in Computer Science Education

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Abstract

This paper presents the state-of-the-art of thinking in computer science. This approach to computer programming is called object oriented programming (OOPS). OOPS is the latest attempt of computer scientists to develop paradigms that more closely reflect the way humans think. We live in a world of objects—cars, building, animals, and so forth. These objects have internal states or characteristics. Objects also do things. They have external behaviors. In OOPS programming, one creates software objects.

Minsky (1986) suggests that the mind can be built from individual processes called agents. Minsky's agents are much like the objects discussed above. These agents contain the data and the rules to perform a specific function when called upon by another agent. They also have the ability to pass messages back and forth. Minsky's model of the mind seems analogous to the philosophy of OOPS programming. Therefore, we suggest that OOPS provides a framework that helps explain human learning. We suggest that OOPS programming should be part of teacher education.

Introduction

Educational technology offers a unique opportunity for today's educators to change the face of education. While cognitive science provides the theoretical underpinnings of educational technology, computer science provides some of the technical tools to make this opportunity possible. However, one of the most difficult aspects of educating today's teachers to incorporate technology into their classrooms is the rapidly changing face of both technology itself and contemporary thinking about what topics should be taught and how they should be presented. This places tremendous pressure on university based computer education faculty to constantly update their knowledge in computer science and educational technology.

When examining the current school curriculum, one sees the emergence of two distinct groups of teachers who use or will use technology in their classrooms. The first group is comprised of teachers who use the computer as a tool, either to deliver instruction through various computer assisted or computer aided tutorials. This group also includes teachers who use specific applications such as word processors, electronic databases and electronic spreadsheets. The second group is comprised of teachers who are concerned with teaching about computers themselves - computer science and computer programming. Many teachers in both groups are self-taught computer users, yet they have little formal, in-depth knowledge about computers or computer programming. This provides a tremendous challenge for those of us engaged in the pre-service and in-service education of computer literate teachers, especially those who will be teaching such advanced topics as computer programming.

This paper presents the view that the relationship between how humans think and how computers can be programmed should be emphasized in the education of teachers in today's technological society. This relationship is represented by a relatively new approach to computer programming called object oriented programming (OOPS). Object oriented programming uses the concept that computer programs can be viewed as active objects. To write a computer program using the OOPS paradigm, one must acquire a new understanding ofthe philosophy and methods of computer programming. Learning new ways to teach the computer (program it) enhances our understanding of human learning.

To understand the philosophy behind OOPS, we first present a general discussion of the concept of objects including some interesting parallels between OOPS programming and contemporary theories on human thinking. We will then apply these concepts to an object that might be represented on a computer.

The OOPS Philosophy

In many ways our world consists of objects. Some objects are passive, others active. Passive objects sit around and wait for something to be done to them. An active object, on the other hand, has knowledge of its internal state. It knows how to operate on its internal state and how to communicate with the outside world. This internal state of an active object consists of data and the methods that work upon the data. In addition, an active object has the ability to accept and send messages to and from other objects. In this sense, active objects are dynamic systems capable of some sort of action when given a message. This is, in large measure, a metaphor for the way humans think and reason.

Minsky (1986) puts forth the fascinating proposition that the mind can be built from individual processes. He calls these processes agents. Minsky's agents are much like the objects we speak of. These agents each contain the data and the rules to perform a specific function when called upon by another agent. They also have the ability to pass messages back and forth. We find Minsky's proposition compelling. It is so compelling that we are led to champion the argument that the philosophy and methods of OOPS programming should be taught to educators. OOPS provides a conceptual framework that will provide teachers with a more comprehensive understanding of learning than occurs in traditional teacher education programs.

Real World Objects

Objects do not exist independently of each other. Many objects have characteristics that make them similar to other objects. For example, a college professor is an instance of the general class of objects called teachers. If you know the characteristics of the class of teachers, you can apply that knowledge to other members of the same class. That is, you can infer thespecific characteristics of a teacher by knowing the characteristics of the class of teachers. This unique mental ability is one of the features that make human beings so adaptable when dealing with new situations.

For example. consider a nonhuman object, a car. A car is an active object that has an internal state, or parts. These parts, the carburetor, transmission, steering mechanism and so forth, follow certain methods of operation. When we send the car the "start your engine" message by inserting and turning the key, the car follows certain processes to use its parts to carry out the message. As the user of the car, we are not required to know the inner workings of the internal combustion engine to get the engine started. Nor are we required to understand the steering mechanism or the inner workings of the transmission to drive the car. To use an object, we only need to know what types of messages the object responds to and what type of response each message causes.

We spoke earlier of classes of objects. When we are confronted with a new car, we recognize it as an example of a class. We understand that the car has much in common with all cars. In OOPS terminology, the specific car inherits characteristics from the class to which it belongs. To use the car, we only need to determine how this specific car is different from the general class of all cars. We know what type of messages cars respond to, but we may need to learn how to make this particular car do what we want. For example, all cars provide an object for signaling a left hand turn. To activate the left-turn signal object, we only need to determine how to send the "turn left" message to that object.

Computer Objects

To understand how OOPS programming works, let us look at an object that might be programmed on a computer. Recall that active objects are designed to have an internal state that consists of information the object knows about itself, which we call its attributes, and ways to manipulate this information, which we call its methods. The object is activated by messages sent to it by other objects or external events. Let us choose as our example the object called rational number. This object has two parts or attributes, the numerator and the denominator. In addition to it attributes, the object also contains methods that describe how the attributes might be manipulated. Some of these methods might include ways to reduce the rational number to its lowest terms, or a process to add itself to anotherrational number. If the object is sent the message "reduce yourself to your lowest terms," the object contains the necessary programming code to carry out the intended action. In summary, given a message, an object performs the function it was designed to do. Like the automobile driver above, a computer programmer using an already programmed object need not be concerned about the internal workings of that object. All one needs to know is what the object does in response to a message. Since the data and code (attributes and methods) are internal to the object, side effects are virtually eliminated. This walling off of the attributes and methods of an object is called encapsulation.

OOPS programmers rarely starts a program from scratch, but rather adapts already existing objects that have the desired characteristics and needed behaviors. For example, suppose you wanted to create an object called integer. It is obvious that integers are particular instances of the general class of rational numbers. Therefore, many of the methods that work with rational numbers should work with integers. If you wanted to program an integer object, you only need to declare it as a descendant of the rational number object. As a descendant, an integer object inherits the characteristics of the rational numbers. All that an OOPS programmer must do to use this new object is to specify the differences between rational numbers and integers. This means that new definitions must be written for methods that produce non-integers. Other methods are left intact. Objects even have a way to recognize whether a message is intended for it or one of its ancestors (objects from which it descended). Because this ability allows a single message to have more than one meaning, it is called polymorphism.

Objects, attributes, methods, messages, encapsulation, and polymorphism are all terms commonly used in OOPS programming. They are also terms that have meaning when applied to human thinking. OOPS objects are quite similar to Minsky's agents that have attributes, they exhibit methods and transfer messages. Furthermore, the mind's agents encapsulate their information and can respond to messages. In light of the obvious parallels between the OOPS paradigm and how the human mind works, we suggest that OOPS programming could be used as an effective tool in educating teachers.

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TECHNOLOGY PROJECTS & THEIR MANAGEMENT

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Introduction

This section of the Annual contains a collection of nine papers that describes not only projects designed to impact on the use of technology in education but the management problems inherent in implementing each of them. The papers have more in common than one might expect upon first reading their titles. Although approach and design, student population, funding sources, and geographic settings are different in each, two themes of mutual concern rapidly emerge. These themes focus on the integration of technology into the curriculum and how to provide the needed education for the teachers that will be using the technology. The difficulties of change are a third thread that ties all of these projects together. These papers, by themselves, seem to highlight the issues that have emerged at each previous Technology and Teacher Education Conferences and likely exemplify the issues that appear throughout this annual.

Projects

Three of the papers represent a panel describing the Christopher Columbus Consortium, a partnership of university colleges of education, K-12 school systems and Apple Computer. Two projects, one from Texas and one in Georgia, are examples of the consortium's goal to foster the effective application of technology into education.

The Texas project, headed by George Culp, linked graduate students and faculty at the University of Texas at Austin and teachers at a school in the Easnes ISD in Austin. Culp's project provided university support for teachers to design and develop HyperCard stacks to meet the objectives of their curriculum and integrate them into current classroom instruction. University research assistants programmed and developed the stacks for the teachers.

The Georgia project was a collaborative effort of the College of Education at the University of Georgia and a high school in Athens, Georgia. This project focused on implementing computer technology by both empowering teachers and helping teachers learn better ways of using computers in the classroom.

The TVA projects (Smith, Wilson, and Shipe) and the East Texas project described by Ginther, Fullwood and Price deal with ILS (Integrated Learning Systems) and their impact on teachers' use of technology. Ginther describes these networked systems as combining computer-aided instruction, computer based information management, and multi-level courseware in a variety of content areas. The TVA project introduces the ILS along with interactive multi-media, wide area networking and other distance learning technologies. The project described in both papers focuses on the effect of the technology in the restructuring process. The research and assessment component is an integral part of this project.

The NCSA Living Laboratory at the University of Illinois (Bievenue and Toth) describes a project proposed to create a computing environment in the school. This culture develops as the teachers and students in the schools interact with the challenges and informal learning environments provided by the NCSA project.

The two papers by Holmes and Scannell describe the work of the Texas Center for Educational Technology. Their first paper outlines a range of research projects supported by TECT. Their many activities support the application of new technology in educational settings, research on the use of technology in education, creation of prototypes for educational use of technology and the use of technology with handicapped students and teachers. The Leading-Edge Partnership, their second paper, describes an interactive multi-media tool developed by TCET and Apple Computer to help Texas districts design plans to integrate technology into district operations.

Integration of Technology Across the Curriculum

Through the years many districts have attempted to find ways to encourage teachers to integrate the use of computers into their classroom instruction. The literature on integration identifies a range of reasons for the failure of these attempts. Lack of teacher training, lack of appropriate software, and lack of support during the implementation process are but a few of those reasons. These, and others, are cited in the following papers.

In the Georgia project Gustafson found lack of support in the form of hardware (in this case, an insufficient number of LCD panels) and lack of adequate software issues that had to be dealt with if project implementation was to be successful. In the Texas project teachers involvement in the design and development of software that met their classroom curriculum needs resulted in integration of that software in a range of classrooms. Software developed in the project is now being offered to other Texas teachers.

Integrated learning systems can provide access to a range of courseware. The courseware can be integrated into district curriculum and goals and made available to students. Mark Sherry's 1990 report on an EPIE study, cited in the Ginther, Fullwood and Price paper, notes that integrated learning systems are well regarded by teachers and students. Their paper speaks to the importance of teacher knowledge of the system software to be able to take advantage of the system and integrate it into the curriculum.

The EPIE study also noted that three quarters of the administrators surveyed responded that they had not restructured their curriculum as a result of adding an integrated system (Trotter, 1990). Trotter reports that Sherry and others say that the structure of the school needs to be altered to make the computer lab an integral part of the day's instruction, not an add on.

According to Smith's assessment of the TVA project it appears that student success greatly increased with the integration of the ILS, IVD and interactive television networks. The key, he notes, is not the technology itself but the ability of those who use it to make it 'invisible' to the students.

Professional Development

Much of what we know about good staff development has been addressed in these papers. Lieberman and Miller (1984) suggest that practical classroom activities, personalized support, in-class help, time for learning, a supportive staff, and leadership that recognizes the range of resources and organizational supports that must surround any implementation effort. Authors in this section refer to consideration of many of these elements in their projects.

Gustafson notes how important the support of the administration was to the teachers at Clarke Central High School. In addition these teachers had written proposals for the ways in which they planned to use the technology if the computer became available to them. Prior to using the computers in the classrooms the teachers took the computers home to become comfortable with them. In addition workshops and courses at the college were available to them. In the Christopher Columbus project described by Culp teachers received the support of the graduate students to make the curriculum needs they had identified come alive in HyperCard stacks. Each of these projects supported the main theme of the consortium to empower teachers learning to use technology.

The strong leadership, as well as the strong staff, was identified as an important element of the TVA project at Ingleside Elementary School. The design of this project included teacher involvement from the beginning. According to the authors, extensive teacher training was a part of the project from the beginning and that helped the teachers feel in control of their situations. Teacher involvement continued during the development of questions about the effects of the impact of technology at Ingleside.

Bievenue and Toth note that most teachers are not prepared for the changes that high technology and the information age are bringing to the classroom and for the students. This belief influenced the plan for the NCSA project. Members of the NCSA staff provided ongoing, on-site support for teachers. There were also weekly seminars offered where teachers could hear about and discuss new ideas for classroom projects using computers.

Change

Researchers in many of the projects noted the difficulty of change for the school-based practitioners. The

TCET aims to help teachers go beyond student acquisition of computer-based skills. One of their goals is to help school districts develop new models of learning and teaching that will support teachers in their use of technology in the curriculum.

In working with the four sites in East Texas Ginther and others cite the importance of ongoing, year-to-year support if changes were to be sustained and developed. Teachers in this project required ongoing assistance while learning how to use the new courseware materials that are provided as a part of the Integrated Learning System. Additionally teachers found it difficult to integrate these materials into their current practice, again requiring support from the lab managers.

In the Georgia project (Gustafson) teachers have integrated technology use into their core beliefs and practices; an indication that the impact of this innovation may be long term. Gustafson's belief that these kinds of changes are critical has been written about by others. In the Ontario schools, Fullan, Miles and Anderson (1987) found that changes in teachers' materials, practices, and, most importantly, beliefs were necessary for change in classroom practices to become institutionalized.

Smith's experience with the TVA project is that the restructuring process comes with the technology. It is up to the people that are involved with it to make it work.

Conclusions

Each of these projects aims to move teachers and students to gain from better uses of technology in the instructional setting. Considerable effort has been expended to offer those who work in schools an opportunity to learn how technology might enhance their work environments. For both the teachers and the students this process can be both exciting and painful. The studies described in this section warn us that we will not meet these goals easily; there will be steps forward and backward as teachers develop ways to work with the technology and as the technology changes our school environments.

Those who plan the range of experiences we have read about in this section, and others like them who continue to dream of ways to help school-based practitioners make use of technology to prepare students for the world of tomorrow may benefit from the following quotation. It is from a novel I recently read and seems to describe a view that might help us all as we move to meet the changes of the future.

> "Change is an easy thing to decide and a difficult thing to do. It is the day-to-day struggle of it that defeats people. Do not despair if old ways look good to you. Despair only if you fall into them too often" (Koen, 1986, p. 613).

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Introducing Teachers to Computer Technology: A Case Study

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Abstract

The Christopher Columbus Consortium project in Georgia focuses on public school implementation of computer technology based on teacher empowerment and teacher use of computers in classrooms. Factors contributing to overwhelming teacher enthusiasm for this project and its contributions to instruction are discussed.

Introduction

Over the years there have been many attempts to promote the use of various forms of technology by classroom teachers in public schools. Most of these efforts have met with little success. Reasons for the lack of success include: top down initiation, lack of teacher training, incompatibility of the technology with teachers' perceived and actual roles in the classroom, and lack of reward for teachers' efforts. In the case of computers, a lack of appropriate software, limited amounts of equipment, difficult to use machines, and the implied notion that teachers were to let the devices take over the instruction, can be added to the list of reasons they have not been widely accepted and used by teachers. While it is estimated that there are over 2,000,000 computers in the schools, there is little evidence they are bringing about the benefits touted by their promoters. Keeping all of these factors in mind, a different approach to introducing teachers to computers and how they might use them was decided upon for the Christopher Columbus Consortium (CCC) project in Georgia.

CCC was the brainchild of Dr. Tom Burnett of Apple Computer and selected Deans of Education at major teacher preparation institutions. In Georgia, the CCC partners are Apple Computer, The University of Georgia College of Education, and Clarke Central High School. CCC is predicated on two simple, but powerful premises: teacher control of the technology and exploration of its appropriate use by individual teachers. Local control is consistent with the concept of teacher empowerment, one of the major initiatives of the College of Education at The University of Georgia. Also, the excessive focus on drill and practice and simple tutorial software fails to make maximum use of computer technology and discourages creative teachers from exploring its use. Thus, creative exploration by teachers, with the help and encouragement of college faculty and their school administration, is at the heart of the the success achieved to date at Clarke Central High School. Describing how this success came about constitutes the remainder of this paper.

Planning the Project

Clarke Central High School, located in Athens, Georgia, has about 1500 students and is an old, but recently renovated building. The student population is mixed racially and economically, and students have widely varying goals and expectations. The principal, Dr. Jimmy Willis, has often noted that, "We send our students both to Yale and to jail." Class sizes are generally 25-30 and there is low teacher turnover. Clarke Central was not a model technology school and few teachers had made use of computers before this project began. This school was chosen as the CCC site for two reasons. First, the principal had already made a public commitment to teacher empowerment and a working relationship already existed between the College of Education and Clarke Central. Second, a related project on school library media center automation was about to begin in the school and was seen as complementing CCC's efforts.

After an initial meeting of the College of Education dean, the superintendent of schools and the author of this paper, it was decided that Clarke Central would be the single site for the CCC project despite stated interest in the project by other schools in the district and the political fallout the superintendent knew he would receive. This author believes concentrating resources at the single site was important to its success. The next step was to meet with the principal concerning an implementation strategy. It was decided to name a Technology Committee to guide CCC's activities. (Shortly thereafter, the Technology Committee was asked to provide input for all forms of technology in the school.) Named to head the committee was an English teacher with little experience with computers, but obviously a school leader respected by his colleagues. Despite his lack of computer experience, this individual had expressed an interest in CCC, although he had to be convinced to serve as committee chair. In retrospect, his selection was a key factor in CCC's success. He brought with him a classroom teaching perspective often not present in technology advocates. He was not interested in computers per se, but rather in what he could do with them to make his classes more interesting and effective. This philosophy became the guide for all of CCC, namely, not technology for the sake of technology, but technology only when it made sense to each individual teacher. An additional part of the philosophy that emerged from committee discussions was that, due to the limited quantity of equipment available, CCC would focus on teacher use of technology. The committee, consisting of six Clarke Central teachers, two students, two college of education faculty, and the principal, met regularly for several weeks to discuss how the project would be conducted.

Early in the discussions, the principal made it clear the committee was in charge and that he was only a resource. To reinforce this point he indicated he would not be a regular participant in meetings and would attend only when asked. Initially this created some concern on the part of the teachers. One reaction was that maybe he didn't care about the project, but this was quickly dispelled by his follow up conversations with the chair and individual teachers about how they were progressing. A second noteworthy reaction of the teachers began to occur when the committee, after discussion, would decide on a specific course of action (e.g., there would be proposals required from teachers desiring a computer). Comments such as, "Can we really do that" and "Is this what he really wants?" were expressed by teachers indicating they doubted they had such authority. The college faculty at this point kept reinforcing the statements of the principal that, yes, he really did believe in teacher empowerment and had given them the authority to make decisions. This was a major turning point in the project and, when recognized by the teachers, resulted in an incredibly heightened level of energy and enthusiasm that they have continued to maintain and have transmitted to other teachers. While the reasons for the success of this project can be oversimplified, it is fair to say that teacher empowerment and focusing on teachers using technology to help them teach represent the heart and soul of this CCC project.

The Technology Committee decided that the only fair way to distribute the computers to teachers was to hold a competition and request proposals as to how they would be used in the classroom. Additional conditions attached were that teachers would team up with college faculty members who would serve as a resource, and that the computers would be available to students before and after school and at other times when they were not being used. Also, teachers would be expected to participate in some form of training and later to write up an evaluation of their experience. Assistance in identifying an appropriate college faculty partner was offered by the college faculty on the committee. However, most teachers already knew someone, usually in their own discipline, with whom they became partners. One of the interesting benefits to the college of this search for partners was the increased attention some academic departments realized they would now need to pay to technology. Although there was considerable concern that the committee would be flooded with many more proposals than there were computers, only one more proposal than available computers was received. This problem was solved by the principal who came up with the funds so that all proposals were funded. Additional funds were found to equip a modest computer lab (10 stations) in the library media center to which students could be taken or sent for specific activities. Unlike other labs, this one began to get extensive use once teachers had begun to use computers in their regular classes. The pattern of lab use clearly indicates lab use follows teacher use, and not the other way around.

Implementing the Project

The teachers received their computers in the late spring and were encouraged to experiment with them only if they had time. Otherwise they were told they could take them home for the summer and short workshops were scheduled during the summer to help them learn how to use them and to examine available teacher oriented software useful in their respective disciplines. Some teachers took college courses in the summer while others enrolled in the CCC workshops or sessions provided by the local regional educational services agency. Some teachers participated in all three forms of training although the only reward received for any of the training was receipt of staff development credits. By fall, all participants had received some training and were ready to go. The math area received particular attention since several math teachers became CCC partners and the college's math education department made a major commitment to the project. As one of their contributions to the project, the department assigned a graduate assistant to Clarke Central to serve as a teacher resource for the entire school year. They also offered special opportunities for the math teachers to review software and plan for use of the computers when school opened in the fall.

Early in the fall one major problem became apparent. Namely that there was an insufficient supply of projcetion panels for teacher use to project computer images using an overhead projector. Most of the teachers wanted to use the computer for whole class instruction, at least some of the time, and the projcetion panels were eagerly sought. Although some additional displays were purchased, they remain in short supply. If we had it to do over again, the committee would likely decide to order one projcetion panels for every computer assigned to a teacher even though it would mean less teachers would have computers. Lack of adequate software was another problem. The teachers' problem was partially addressed by linking it to a problem at the college; lack of real world experiences for students enrolled in software design courses. The result is an arrangement whereby students at the college are assigned to teachers at the school to develop "real" software that teachers request. Everybody wins. The college students gain valuable experience working on real projects with real clients while the teachers get needed software specifically designed for their use. The college students also have been able to make teachers aware of other new commercial software and in some cases help them learn how to use it.

At this time, CCC is in its second year of operation. The Technology Committee continues to function and has expanded its purview to all forms of technology. It is also working closely with district level personnel in formulating a long term strategic plan for technology and identifying required resources. Other teachers in the school are now requesting computers, but unfortunately the current budget situation is so bad, no funds are available to meet their requests. CCC teachers have demonstrated exceptional generosity in sharing their computers with these other teachers, but long term there is a commitment from the principal to finding the necessary resources to meet all requests. Several teachers and the technology committee itself are preparing proposals to a variety of sources hoping to obtain the needed funds.

Conclusions

Why do we consider CCC to be a success? First, teacher morale at Clarke Central is very high despite the bleak financial situation in the school district. Participating teachers speak glowingly of what the computers have done to make their classes more interesting to students and exciting to themselves and other teachers eagerly await the opportunity to have a computer as soon as funds are available. They feel their students are now learning more of both the traditional and new kinds of knowledge and skills. Despite the cautions raised by the college faculty, they feel confident these results will show up on standard achievement tests within the next few years. They now publicly claim that, given an adequate amount of computers, they can really make a difference. These are empowered teachers who believe they can (and already are) making a difference. They are committed to the technology because it helps them do what they do better. They want to learn more about it and share the benefits with their students. This technology is being integrated into their core beliefs and practices and the impact will be long term. CCC has already made a difference to participating teachers in this school and it will spread to many others limited only by available resources.

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The Christopher Columbus Consortium Partnership

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Abstract

The Christopher Columbus Consortium is a partnership initiative involving university colleges of education, K-12 schools, Apple Computer, Inc., and other businesses. Currently, there are over 37 Consortium sites world-wide. The sites focus on research, development and training initiatives which foster the effective application of technology into education. While Consortium efforts span all curriculum areas and all grade levels, a primary focus area for the Consortium is on teacher and faculty member empowerment.

Introduction

The Christopher Columbus Consortium is a partnership of university colleges of education, K-12 school systems, Apple Computer, Inc., and other businesses, fostering effective applications of computers and related technologies in education.

The Consortium members engage in activities including research, development, evaluation, dissemination, implementation, and training to test technological innovations in learning and instruction. The Consortium facilitates communication and collaboration to enhance the efforts of individual members through electronic telecommunications, newsletters, and annual meetings.

A strength of the consortium is the sharing, among consortium members, of information obtained via the activities listed above, especially as it relates to specific areas of study such as math, science, language arts, social studies, teacher productivity and presentation, information/data retrieval, special education, counseling/guidance, and other areas. While all consortium colleges and schools will be engaged in activities in most of these areas of study, in order to foster effective communications between and among consortium members, each college of education helps facilitate communications in a particular area of study.

An original focus of the Consortium has been on empowerment. By placing technologies directly into the hands of teachers and faculty members, the Consortium has sought to study how educators appropriate the technologies, how they infuse them into their classrooms and into their research, and how curriculum and instructional practice change following the intervention of an "educator workstation".

Currently there are 37 Consortium partnership sites throughout the world. In each partnership site, the participants include a university college of education, an elementary, middle, and/or high school, Apple Computer, Inc., and additional business partners.

Research

Consortium members have engaged in a wide variety of research projects relative to their mission, including research into teacher empowerment, the impact of computers in the classroom, the impact of technology on the writing process, the impact of technology related to collaborations, teacher and student attitudes, telecommunications as a research and development tool, the impact of computer technology on facilitating the growth of language skills among Limited English Proficient students, the nature of information in student developed HyperCard stacks, and the impact of technology use on teaching styles of teachers and faculty members.

One important finding thus far supports the research conducted by Dwyer, Ringstaff, and Sandholtz (1990) into teacher beliefs and practices. The teachers in the Consortium schools have progressed through a series of phases in their learning. As stated by Dwyer, Ringstaff, and Sandholtz, these stages are entry, adoption, adaptation, appropriation, and invention. While teachers seemingly have to go through all of these stages, the heart of the research into teacher empowerment being conducted by Consortium schools and universities centers on how we can accelerate their progress through these stages.

Development

In conjunction with the research being conducted at Consortium sites, various development activities are an integral part of the collaborations between the universities and schools. Development efforts have typically been centered around courseware development, including multimedia-based courseware, and models for conducting courseware development. Actual courseware development at Consortium universities and schools has been centered around providing customized applications for teachers to utilize in their classrooms. Efforts in this category range from courseware designed to facilitate music appreciation in elementary students, to multimedia-based systems for middle school science, to graphic-oriented software for teaching linear equations.

As important as the actual courseware development efforts have been, the models for facilitating this courseware development provide insight into how more customized courseware can be made available to teachers and students. A primary vehicle to accomplish this task which has been adopted by many Consortium partners is the pairing of university faculty and graduate students with classroom teachers. These teams have worked collaboratively as research, design, and development partners to produce a wide variety of software tailored to specific classroom needs. In fact, this model has been taken to a new level at Trinity High School, in the Hurst-Euless-Bedford school district, by having high school students who have been trained in advanced multimedia development and design work in partnership with teachers in developing courseware applications across the curriculum.

Training

Perhaps the most important collaboration between all of the parties involved in the Consortium is that involving training of teachers and faculty members. Many models have emerged from the Consortium sites. These have ranged from traditional college-credit courses, to mini-workshops, to summer institutes, to providing training during teachers planning and lunch periods. Training topics have included productivity application, curriculum software solutions, instructional design, *HyperCard* development, multimedia systems, telecommunications, and distance learning.

Conclusion

While all of the areas of research, development and training form the core of the projects and activities Consortium members are engaged in, the true heart of the Consortium is in the collaboration between and among its members. Teachers and faculty members who have never talked together before, let alone been involved in a collaborative effort, are now working together, learning together, and discovering new ideas. As Dr. Alphonse Buccino (1991), Dean of the College of Education at the University of Georgia and one of the founders of the Consortium once said in describing the most important aspects of the Consortium, "The first contribution we can make in collaborations or partnerships such as this is generating new ideas, contributing to that storehouse of ideas of how we make our educational system more effective and productive than it's been." The overall goal of the Consortium is to provide a mechanism for member schools and universities, working collaboratively, to generate and test these new ideas.

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An Approach to Collaborative Software Development

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Abstract

Through participation in and support from the Christopher Columbus Consortium, sponsored by Apple Computer, Inc., and the Texas Center for Educational Technology (TCET), teachers and administrators at two Austin, Texas area elementary schools, working with graduate student research assistants and faculty at The University of Texas at Austin, are collaborating on the design and development of a series of *HyperCard* stacks for elementary school use. The underlying principle of the collaborative project is that the stacks are *designed by teachers* to meet needs *defined by teachers*. Sixteen stacks have been completed as of December 1991 and are available at nominal cost from TCET.

Positive outcomes from the project include new channels of communication and collaboration, increased interest in research in educational technology, and integration of technology into the schools.

Introduction

In the early fall of 1990, I began a series of hands-on workshops introducing *HyperCard* to teachers at Valley View Elementary School in the Eanes ISD, Austin, Texas. At that time Valley View and the College of Education at the University of Texas at Austin were the two local partnership schools working with Apple Computer, Inc., in the Christopher Columbus Consortium. (Highland Park Elementary School in the Austin ISD joined the consortium later that year.) The teachers were consistent in praising the educational potential of *HyperCard* and had an interest in developing materials relevant to their needs, but were just as consistent in stating that finding the time for such development would be a problem.

Also at this time, I was teaching a graduate course, *Hypermedia in Instruction*, that included the requirement for each student to design and develop a semester project using *HyperCard*. I leave the specific content completely in the hands of the students and have found that they can be extremely creative and self-reliant. However, this particular semester a few students asked if I could help them by suggesting some topics for their projects. It occurred to me that there was a wealth of ideas for semester projects residing with the teachers at Valley View. Therefore, I arranged for the students and teachers to get together to discuss and outline their interests. By the end of the semester, five *HyperCard* stacks designed by teachers and developed by students were completed. While the stacks did not meet the requirements to be of commercial quality, they nonetheless were highly successful in meeting the objectives for both the designer-teachers and developer-students; definitely a win-win situation.

The Texas Center for Educational Technology

Concurrently, I was also serving as a site coordinator for the Texas Center for Educational Technology (TCET). The center, established by legislative statue in June 1990, is located at the University of North Texas in Denton, with supporting sites at UT-Austin and the University of Houston at Clear Lake. Its first year activities focused on research and development in areas such as telecommunications, design of computer-based instruction to accommodate different learning styles, interactive multimedia, student learning in special populations, and emerging learning systems. When one of the faculty members working with the center left The University of Texas at mid-year, the opportunity arose to make a more formal process of the collaborative software design and development initiated informally in my class. Following a proposal to the center, support was provided to fund teachers as consultants and graduate students as research assistants in a Collaborative Software Development Project.

Since February 1991, teachers and administrators at Valley View Elementary School and Highland Park Elementary School, along with graduate student research assistants and faculty in the College of Education at The University of Texas at Austin, have been collaborating on the design and development of a series of *HyperCard* 2.1 stacks for elementary school use. The underlying principle of the collaborative project is that the stacks are *designed by teachers* to meet needs *defined by teachers.*

Two teachers at each school are each paid $500.00 per semester as consultants to provide the objectives, content and sequence for the stacks. The research assistants, who are graduate students in Instructional Technology, are paid about $8.00-10.00 per hour to develop the stacks.

A basic systematic approach is followed for design and development. For the purposes of the project, the approach and responsibilities are defined as:

- Define content and objectives: (Teachers)
- Outline the instructional sequence: (Teachers)
- Develop the stacks: (Research assistants)
- Pilot test the stacks: (Research assistants and teachers work together. Research assistants get "over-the-shoulder" feedback from the teachers regarding design and presentation.)
- Revise stacks based upon teacher feedback: (Research Assistants)
- Review stacks: (Research assistants and teachers together. Further revision as needed.)

As of December 1991, the collaborative software development project has completed 16 stacks, with an additional six stacks nearing completion. The completed stacks are distributed by TCET at a nominal cost, usually five dollars or less.

Support for the project has been extended by TCET through August 31, 1992. Plans are for an increased focus on additional units incorporating the laser videodisc, *Windows on Science*, produced by Optical Data

The available stacks are:

Name	*Area*	*Grades*
LETTER PEOPLE	The alphabet with word examples	K-1
FARM ANIMALS	Information about selected animals	K-1
POCKETFUL OF RHYMES	Six classic nursery rhymes	K-1
DINOSAURS	Information about selected dinosaurs	K-3
TEXAS ANIMALS	Information about selected animals	1
THE USA	Selected information about the states	1-2
FOOD GROUPS	The basic four food groups	1-3
CAVES	Information about cave formations	1-3
THE RENAISSANCE	Selected inventions of the period	3-5
TEXAS FACTS	Selected information about the state	3-5
FIDDLESTICKS!	Families of musical instruments	4-6
TRUMPET OF THE SWAN	Information related to the book	4-6
PLANT UNIT	Optical Data Windows on Science Use	1-3
ANIMAL UNIT	Optical Data Windows on Science Use	1-3
WATER CYCLE	Optical Data Windows on Science Use	4-6
THE RAIN FOREST	National Geographic Video Disk Use	4-6

Corporation, 30 Technology Drive, Warren, NJ 07059.

For further information about the stacks or TCET, contact the Texas Center for Educational Technology, P. O. Box 5155, University of North Texas, Denton, Texas 76203-5155 (817) 565-4433.

Closing Comments

Several positive outcomes have resulted from the project and the partnership of the participating schools, the Christopher Columbus Consortium and the Texas Center for Educational Technology. New channels of communication and collaboration have been opened between all members. The inservice teachers greatly appreciate being able to state in their own terms the design of stacks to meet their needs as they know them, rather than needs as perceived by others outside the classroom. One of the stacks, *Fiddlesticks!*, won first place in a national contest sponsored by the consortium. Interest has increased in the research components of technology in education, which has facilitated cooperative studies. Motivation is high. Technology is being integrated in the schools, and the teachers are willing and active participants in the process. All teachers are making use of at least one type of computer application, and, in fact, some teachers are now finding the time to design and develop their own *HyperCard* stacks.

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Tennessee Valley Authority, Technology, and School Restructuring

Charles H. Wilson
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Ron W. Shipe
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Abstract

As a part of its program to upgrade the educational infrastructure in its seven state region, the Tennessee Valley Authority is joining with the Athens City Schools in Tennessee to investigate the effect of introducing a number of educational technologies into a single school. These technologies include integrated learning systems, interactive videodiscs, multimedia, wide area networking, and other distance learning technologies. A research plan will document how the capabilities of the technology lend them selves to restructuring student–teacher roles, management systems, school organization, community learning, and other education subsystems.

Introduction

Most people in the South think of the Tennessee Valley Authority (TVA) as a power company; however, TVA also has a charge from Congress to enhance the economic competitiveness of a seven state region comprising all or some of the following states: Tennessee, Virginia, Kentucky, North Carolina, Georgia, Alabama, and Mississippi. Over the years it has become clearer that both the skills of the current workforce and the educational infrastructure for future workers are critical for economic growth. Accordingly, TVA has formed partnerships with schools, businesses, and other state and federal agencies to improve education across the Valley.

One of the strategies for improvement has been the introduction and evaluation of various educational technologies. Integrated learning systems (ILS), interactive videodisc technology (IVD), and fiber-based, two-way, interactive television networks have been utilized with significant success. In fact, it now appears from the research on these programs that when educational technologies are integrated into a school program, the success of students is greatly increased. The key to this success, however, is not simply the technology itself. Technology must become as invisible to students as pencils are.

As a result of research documenting these ideas, several very interesting notions began occurring. For one thing an ILS allows for an individualized educational plan for each student. Fiber–based, wide area networks permit immense databases, including images and video, to be available to small schools in remote locations. Presentation technologies, such as desktop publishing and now desktop video, give students the power to publish projects to their peers and parents using a wide variety of multi–media. If all these technologies were in place in a single school, what would happen?

If every student can truly progress individually, are twelve grades needed? Are any grades needed? If students can call up the Library of Congress, the Smithsonian, and National Geographic at their workstation, why buy textbooks? Do all students need to learn the same things at the same time? Must teachers have all students turn to page 42 in the mathematics text and work problems 1–30? Can any teacher present material as effectively as a good video? Must there be a stack of objectively graded papers on the teacher's desk at the end of day which certify that each student has or has not mastered State Objective 432.5? If teachers were to become facilitators and coaches more than information sources, how might this affect pre-service teacher training?

The single question becomes what would be the impact of all the educational technologies on the total environment of a school? Would governance be affected? teacher roles? assessment? instructional methodologies and design? management? student success?

Implementation of ILS at Ingleside School

These questions had also occurred to Mr. Ben Wilson, Principal of the Ingleside Elementary School (K–6) in Athens, Tennessee. Late in the 1990–1991 school year he contacted the TVA for technical assistance, and it soon became clear that both the federal agency and the school system both were eager to proceed with research. The Ingleside School was an ideal site. The school had strong leadership and a strong faculty who were unafraid of new ideas. Twice the school had won the U.S. Department of Education's award for excellence—a distinction equaled by only three other schools in the United States. *Child* magazine in May, 1991, had named the school as one of the top ten in the United States. Quickly the TVA and Mr. Wilson agreed to set up the experiment.

The Athens School Board was a bit hesitant, however. Despite the fact that they were used to a progressive administration, all this required some thought—besides wouldn't this be favoring one school over all the others? However, Dr. Robin Pierce, the school superintendent, carefully explained that such a project was well within the five-year plan for the introduction of technology which the board itself had adopted for the entire system. Funds to introduce technology into the entire system simply were unavailable; moreover, the research would give some real answers as to how technology would really work in a specific school within the system. After consideration the school board concurred.

Change can be frightening for anyone, and the teachers too were no exception. It may be argued that elementary teachers are less worried about divergent activities in the classroom than secondary teachers, but it was clear from the start that thorough training must be done and that teachers must have control of their own situations. As had been the case with each of the projects the school had undertaken, the teachers themselves met to discuss the merits and demerits of such a program. When the vote came, all but one welcomed the plan — provided thorough teacher training would be provided.

Beginning in September of 1991 the technology began to arrive. Cable began to be strung. Boxes of computers lined the hallways. The plan was to install the Wicat ILS with four terminals in each classroom. In addition, for kindergarten and first grade, a*Writing to Read* computer lab of thirty computers was available. Interactive videodiscs were purchased, and plans began to be laid to hook up the school to wide area networks, and other distance learning technologies, even to super computers. The research component, which is discussed in detail in another article, was planned and implemented.

Already, less than three months into the project with not all of the technology installed, some startling ideas for restructuring have begun to appear. The idea of grades is being seen as unnecessary. Since students can proceed at their own rate, why not let them? A whole language, multi–disciplinary approach is being suggested so that small groups of students can work on projects using databases and electronic media which can eventually replace textbooks—not books but textbooks. Performance assessment through multi–media student products and portfolios. Plans are being made to tie in public assistance housing projects with the electronic network in the school not only for the benefit of the schools' at–risk students but for their parents as well. A proposal has been sent to RJR Nabisco to expand the technological base. Athens has joined with the TVA, the University of Tennessee, Bell South, and other school systems, agencies, and businesses to become a site for research and development under proposed funding from the New American Schools Development Corporation. It has been as if the introduction of technologies which allowed for real evolution has unleashed a river of creative change.

Conclusions

The model that is evolving here, however, is not meant to be a norm for everyone else. There are many ILS vendors; many video discs, many networks. There are many kinds of governance. The point is that technology brings re–structuring with it; and once creative people understand how it can work, they will change the structure to match their tools.

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Assessing the Impact of Technology on Education

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Abstract

The introduction of new technologies produces changes in the entire school system. This paper presents a systems approach to analyzing the effects of these changes on school restructuring. The research was centered at Ingleside School, in Athens, Tennessee, a model technology school developed in cooperation with the Tennessee Valley Authority. An argument is presented that adaptation to new technology is dependent on the school environment, teaching style, student interest, and parental involvement.

Introduction

Most research to date has assessed the effects of individual pieces of technology in specific classroom settings; not many research efforts have measured the effects of technology on the entire school. This paper presents a systems approach to assessing the impact of technology on education. The research is being conducted at Ingleside School, in Athens, Tennessee, USA, a Kindergarten through Sixth Grade school which is completely technology based: several computers are in every classroom, central computer labs exist for projects and publishing, and closed circuit TV, videodiscs, and CD-ROMs are in use. This systems approach presents a method for ascertaining the impact of these technologies on teachers, students, parents, and administrators.

Assumptions About Technology Use in Education

What impact should technology have on the school environment? Dede (1990) argues that current information technologies—computers, videoplayers, television—can improve instruction because:

1) intelligent devices can create learning environments tailored to individual student needs;
2) educational technologies can present complex, motivating simulations and multimedia experiences otherwise unavailable to learners;
3) sophisticated technology can reduce teachers' involvement in training students about basic concepts and skills, freeing instructors to focus on the higher-order and human-centered aspects of education;
4) educational technologies can unobtrusively collect detailed information essential for the diagnosis and evaluation of individual learner performance;
5) distance learning technologies can bridge barriers of distance and time to deliver instruction to students who have no other means of access to this knowledge;
6) computer-supported cooperative learning can enhance small group interaction as a pedagogical strategy;
7) using information technology in schools prepares students to use similar devices in societal settings; and
8) empowering environments for creating learning

materials (e.g., sophisticated authoring systems and advanced tools for instructional design) can speed curricular evolution.

Current research, however, is only suggestive as to whether or not these changes actually occur (Sheingold and Tucker 1990). In fact, Sheingold and Hadley (1990), in their survey of the computer experiences of accomplished teachers, suggest that changes in the classroom do not come easily. For technology to work in actual school settings, at least three factors must be present: (1) teachers must be motivated and committed to student learning and to their own development; (2) teachers must be supported by school administrators and other teachers; and (3) teachers must have access to sufficient quantities of technology. Even with these three factors operating, Sheingold and Hadley note that it may take three to five years for teachers to become completely comfortable with the use of technology in the classroom.

A Systems Approach

To ascertain the full effects of the introduction of technology at the Ingleside School and to test the assumptions proposed by Dede, a systems approach argues for investigating the impact of this technology on all groups affected: teachers, students, administrators, and parents. This approach raises many research questions. For teachers, the following questions are important.

- How do the new technologies affect the way a teacher structures the classroom?
- How does a teacher integrate the new technologies into existing curriculum frameworks?
- How do the new technologies affect the way a teacher assesses what a student knows?
- What problems or resistances to the new technologies are encountered and what effects do these problems have on the new technologies into the classroom?

For students, the following issues need to be addressed:

- Which of the new technologies encourage the most interest and activity on the part of the student?
- Is a student's learning style affected by the new technologies?
- Is there a shift to more cooperative, active learning or a shift to more self–directed learning on the part of the student?
- Is a student's attitude toward both learning and school changed as a function of the technologies?
- Do technologies aid learning by some students but impede progress by others?

For administrative and school staff, other questions surface.

- How supportive are school administrators and staff of the new technologies?
- Do the new technologies encourage more communication and collaboration between administrators and teachers?

Finally, the effects on parents might include:

- To what extent are parents supportive of the new technologies?
- Do the technologies encourage more school/parent communication?

Answers to these questions are being investigated through several instruments: interviews with teachers, students, and parents; classroom observations; computer records; and teacher and student portfolios.

Teacher/Student Reactions To Technology

Preliminary findings suggest that the adaptation to new technologies is dependent on the school environment and a teacher's attitude toward technology and her teaching style. A positive attitude toward change as well as a willingness to let students take control of learning facilitates the transition to uses of technology as evidenced by the following teacher's comments: "We are moving away from traditional teacher–directed learning to a system in which students take greater responsibility for their learning. The computer individualizes learning...." And "Changes have occurred because of the willingness of the faculty to experiment with new trends in educational philosophy as well as the encouragement of the principal to try new strategies."

Another advantage of new technologies, especially networked systems, is that it allows teachers to collaborate. As one teacher said "The most important change is the way the teachers are growing closer together. The technology is providing a common link."

The incorporation of new technologies is not always positive, even for experienced teachers. As one teacher commented "I am a classroom teacher. This new technology 'stuff' is about to get the best of me. Between scheduling students, coordinating groups, and keeping things on time, I could scream!"

Student experiences and attitudes towards technology are affected by their previous experience and classroom interactions. Students who are already facile in a computer environment, either with use of technology at home or through video games, adapt quickly. As with all material, the teacher's attitude can also transfer to the student. For instance, at one point during this project, the system crashed. From observational research, it appeared that teachers who were nervous about this malfunction engendered students who were also nervous.

In conclusion, the introduction of new technologies affects the entire system of the school. Reactions by students, teachers, and parents are as variable as the nature of the different technologies introduced.

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Assisting Teachers with Rapidly Changing Integrated Learning Systems Technology

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Abstract

This study was conducted in a large suburban Texas school district that was one of the first school systems to make a multi-million dollar purchase of an integrated learning system. Over the last decade, this school system has continued to purchase and upgrade its ILS system so that every elementary, middle, and high school in the district now has one or more computer labs. At the time of the initial purchase, teachers were provided with multiple day workshops on how to use the ILS. However, during the years since this initial training, resources for staff development have become scarce and extensive formal training has not been conducted. The major purposes of this study were to: 1) design and implement a pilot training program that used existing resources to provide teacher training and support with emphasis on integration of classroom curricula with the ILS; 2) determine the strengths and weakness teachers exhibited in relation to their knowledge and understanding of the ILS before and after training; and 3) establish if such a training program could be associated with academic gains as measured by a State mandated standardized test.

Four elementary schools were selected to participate in this project. At each school teachers completed a pre-training assessment questionnaire and a post-training assessment questionnaire. Sixty-nine teachers completed the pre-training instrument and 63 completed the post-training instrument. The questionnaires were designed to measure a teacher's knowledge of various features of the ILS and self-reported behavior regarding instructional uses and practices with the ILS. In addition, 32 teachers were directly observed while they were in the computer labs with their students.

Training was provided by an employee of the ILS vendor who was based permanently on-site in the school district. Pre-training questionnaires were administered at the beginning of the workshop; six months later post-training questionnaires were administered. After the initial workshop, the ILS consultant and the lab managers worked with teachers during the school day to reinforce and follow-up on initial training.

Observation of teachers in the labs showed that the typical teacher divides their time in the lab between observing students (30%), providing assistance (55%), and other duties (15%). Evaluation of results indicated that, after training, teachers were more knowledgable about the ILS and that they reported using the system more effectively. Teachers differed in relation to their knowledge about the ILS and these differences were related to years experience, grade assignment, and campus. Gains in academic achievement were found on all campuses where training was conducted. Implications of these findings was discussed.

Introduction

Once a novelty in education, Integrated Learning Systems, also known as integrated instructional systems, are now widely used in many school systems across the U.S. These networked computer systems, which typically are located in a central location within each school, combine computer assisted instruction, computer based information management, and multi-level courseware in a variety of content areas. In a report sponsored by the Educational Products Exchange Institute (1990a), Mark Sherry states that integrated learning systems are regarded positively by most teachers and students. However, Sherry (1990b) notes that these systems are often not well integrated or coordinated with the regular instructional activities provided by teachers. He suggests that teachers "need training in how to coordinate the use of the ILS with their regular classroom instruction."

One of the first school systems in the country to make a multi-million purchase of an ILS is a large suburban school system in Texas. Over the last decade, this school system has continued to purchase and upgrade their ILS system so that every elementary, middle, and high school in the district now has one or more computer labs. At the time of the initial purchase, teachers attended multiple day workshops on how to use the ILS. However, during the years since this initial training, resources for staff development have become more scarce and extensive formal training has not been conducted. The major purposes of this study were to: 1) design and implement a pilot training program that used existing resources to provide teacher training and support with emphasis on integration of classroom curricula with the ILS; 2) determine the strengths and weakness teachers exhibited in relation to their knowledge and understanding of the ILS before and after training; 3) establish if such a training program could be associated with academic gains as measured by a State mandated standardized test.

Procedure, Materials, Subjects

Four elementary schools participated in this project. These schools were selected, in part, because the academic achievement of students at these schools was targeted for improvement by school officials. At each school teachers completed a pre-training assessment questionnaire and a post-training assessment questionnaire. Sixty-nine teachers completed the pre-training instrument and 63 completed the post-training instrument. The questionnaires were designed to measure a teacher's knowledge of various features of the ILS and self-reported behavior regarding instructional uses and practices with the ILS. Each questionnaire contained 37 questions. In addition, 32 teachers were observed while they were in the computer labs with their students. A check list and time sampling procedure were used to record behaviors that teachers exhibited while in the labs with their students.

Training was provided by an employee of the ILS vendor who was based permanently on-site in the school district. During the beginning of the school year a one-day workshop was provided for all teachers in the four schools selected for this study. The focus of this workshop was on curriculum and management features of the ILS and how teachers could integrate classroom instructional goals with the ILS curriculum. Specific examples and practice were provided and lab managers were also present. Pre-training questionnaires were administered at the beginning of the workshop; six months later post-training questionnaires were administered. After the initial workshop, the ILS consultant and the lab managers worked with teachers during the school day to reinforce and follow-up on initial activities. The duration of these contacts was typically less than five minutes; frequency depended upon teacher request and availability of the consultant or lab manager.

Results

Eleven of the 37 questions were designed to measure knowledge about various features of the ILS. These features were identified by the ILS consultant as most important for effective use of the ILS. They included features such as selecting pass/fail criteria; resequencing lessons; the need for assigned seating in the laboratory; skipping lessons; progress reports; addition or deletion of specific activities; and other aspects of the ILS.

Analysis indicated that the pre-training knowledge levels were generally high, but not perfect for most teachers. Post-training results showed a gain in knowledge for 8 of the questions; two showed small decrements and on one question teachers did considerably poorer after training. For questions 4 (can lessons be resequenced?) and 8 (must assigned seats be given to students), the gains were statistically significant.

Teachers also were asked several questions that related to their knowledge about computer assisted instruction and microcomputers. These questions were not specific to any ILS, software, or hardware. Responses indicated that this group of teachers were considerably less knowledgable about CAI and microcomputers, in general, than they were about the specific features of the ILS used in their school. Post training outcomes showed no change in teachers' knowledge about CAI or microcomputers, as expected. In addition, teachers that were more knowledgable about the ILS were not correspondingly more knowledgable about CAI or microcomputers.

Teachers were aked 15 questions about their behavior and practices while students are in the computer labs. Analysis of pre and post test responses indicated that, after training, teachers were significantly more likely to exhibit instructional appropriate behaviors for 9 out of the 15 behaviors surveyed. Specifically, after training teachers reported that they were 1) less likely to complete alternate instructional duties while their class was in the learning center; 2) more likely to submit change of request forms; 3) more likely to tell students to use the help key for keyboard assistance; 4) more likely to ask the learning center manager to modify the lesson sequence; 5) more likely to check student progress by noting their activities scores; 6) less likely to interrupt students during lessons; 7) more likely to mention examples from the ILS curriculum during classroom instruction; 8) more likely to use assessment information provided by the ILS; and 9) more likely to use the special assignment feature. The other six behaviors changed in the positive direction, but not at statistically significant levels.

Four questions were designed to determine how frequently teachers were using the instructional management resources included with the ILS. After training, teachers reported that they more frequently: 1) submitted change of requests to the learning center managers; 2) made use of the special assignment feature; 3) reviewed curriculum reports; and 4) requested an individual student report. For all four questions, pre and post test changes were statistically significant.

As noted earlier, 32 teachers were observed more than once in the learning centers. Compilation of the observations indicated that the typical teacher spends about one third of their time in the learning center walking from terminal to terminal observing students. About 25% of the teachers' total time was used responding to questions from students and 30% was spent providing teacher initiated assistance to students. The remaining 15% of the time, teachers were talking with the lab manager or working on paperwork. It also was observed that the lab manager often acted as an instructional resource to both students and teachers.

Differences between school campuses were identified. Among the four schools included in this study, significant differences between schools in relation to teacher knowledge about the ILS were present. Additional interviews were conducted with selected school personnel to provide greater insight into this outcome.

The relationship between number of years of teaching experience in the school system and knowledge about the ILS was examined. Information concerning two aspects of teaching experience was statistically significant—years experience at the current school and years experience in the school district. For each aspect of experience, the relationship between knowledge about the ILS and teaching experience was negative (inverse). The correlations were -.49 for years experience at the current school and -.35 for years experience in the school district. Since this outcome was somewhat counterintuitive, additional analysis was conducted. This analysis, which also produced statistically significant results, indicated that more experience at a particular school is, in fact, associated with greater knowledge about the ILS, up to a certain point. For teachers with six or fewer years experience at a particular school, greater experience is associated with greater knowledge. For teachers with more than six years experience, greater experience is not associated with increased knowledge. In general, teachers with more than six years experience at a particular school tended to be less knowledgable about the ILS than teachers at the same school with less experience.

In the spring, yearly state mandated criterion referenced tests were administered to all students in grades 3 and 5. This test covers skills in reading, writing, and math. For the four schools selected for this study, these results were compared with the previous year's outcomes on this test. Results were analyzed by grade level, by school, by content area, and by total test score. At virtually every grade level, in each school, for all content areas, students showed improvement from the previous year. Table 1 shows the changes in total scores, expressed in percent mastery, for grades 3 and 5 for each school.

Table 1
Annual Changes in Percent Mastery
in Total Scores

School	*Grade Level*	*% Change Mastery*
School 1	Grade 3	+31%
	Grade 5	+15%
School 2	Grade 3	+12%
	Grade 5	+14%
School 3	Grade 3	+37%
	Grade 5	+19%
School 4	Grade 3	+18%
	Grade 5	+26%

Discussion

ILS installations are complex and rapidly changing. While teachers may use the system on a daily basis, this does not mean that they will be aware of new features or use existing features in an optimum manner. In general, the teachers involved in this study were not aware of all the important features of the ILS. This is not surprising, since many of these teachers were hired after the installation of the ILS and have received little structured training on how to use the system. In addition, teachers that are familiar with microcomputer technology in general do not appear to be advantaged in use of the ILS. The ILS employs specialized software and hardware that most persons would not typically encounter outside of this environment.

The results of this study indicate that training does affect both teacher's knowledge and behavior. Even with the minimal training received, teachers became more knowledgable and, more importantly, reported that their behavior changed in appropriate ways. It is also likely that the school principal and lab manager are critical persons in terms of how effectively teachers use the ILS. In particular schools in this study, teachers were more likely to use the ILS effectively and this is probably largely related to support of the ILS by the school principal and to differences in lab managers. Principals differ in how much emphasis and support they express to teachers for the ILS. Lab managers that can educate teachers regarding the new features of the curriculum or management system are valuable; managers that can also provide teachers with suggestions on how to relate classroom curriculum to the content of the ILS are particularly helpful. However, observation of teachers in the labs indicated that some teachers see the manager as the system expert and allow the manager to take all the responsibility for interacting with children and providing assistance while children are in the lab. This can create a duality of perception in the minds of students—in the classroom the teacher knows best but in the lab the manager is the person to ask for help. This dichotomy supports the division between these two areas of the school program.

One of the interesting outcomes of this study related to the relationship between the number of years experience and facility with the ILS. In particular, 6 years experience appeared to be a critical number. Additional investigation revealed that the ILS was installed six years before the beginning of this study. This means that teachers with six or fewer years experience at a particular school typically had always taught in an environment where the ILS was present; those with more than six years had several years of experience pre-ILS installation. It is possible that these more experienced teachers had developed strategies and approaches that did not include the use of computers as a teaching tool. When computers were introduced,these teachers may have maintained their previous tried and true strategies and thus have been less interested in using and learning about the ILS.

One of the outcomes of this study that was most pleasing to school administrators was the increase in standardized tests scores at each of the four schools. The ILS provides extensive diagnostic and remedial resources directly connected to the State mandated criterion referenced exam that is given every year. In fact, it appears likely that one of the main reasons for the continued substantial investment in this ILS is to increase test scores. If teachers more effectively use the ILS to identify specific academic weakness and then select both classroom and ILS instruction to remediate these weaknesses, it seems likely that achievement scores will increase, up to a certain level.

In summary, teachers do require continuing year-to-year training and support to use the ILS most effectively. Teachers who have experience in instruction before the introduction of the ILS may need additional assistance in modifying their teaching strategies to include the ILS as a resource. All teachers need to know how to coordinate and integrate the ILS content with classroom curriculum and activities. Principals and lab managers are important in terms of how teachers regard and use the ILS. If the ILS is directed at increasing standardized achievement scores, additional teacher training is probably helpful to achieve this outcome.

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The NCSA Living Laboratory: Preparing Students for a High-Tech World

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Abstract

There is evidence that students need to be better prepared for their world. The information age is here and schools are not currently equipped to prepare their students for the high technologies and advanced sciences. The NCSA Living Laboratory is designed to prepare teachers and students for the changes needed in education. This project proposes to create a computing environment in the school—a computing culture built on a critical mass, so that each teacher has knowledgeable and interested peers, and the school's environment provides teachers and students with challenges and informal learning opportunities. The NCSA Living Laboratory creates a total computing environment by encouraging school activities, after school programs, and summer activities for students and teachers. These activities and their successes are discussed in this paper.

The Need to Be Prepared

There is evidence that students need to be better prepared for their world. The information age is here and schools are not currently equipped to prepare their students for the high technologies and advanced sciences. Even though society is moving toward the information age, schools are still organized by the factory model. If history is any indication, schools will eventually be organized by an informational technology model, and the NCSA (National Center for Supercomputing Applications) Living Laboratory intends to make that transition a smooth one.

The American educational system is already in a process of restructuring. President Bush has introduced a new plan, known as *America 2000*, to lay a new educational foundation. If this bill passes Congress and the outlined goals are met, it will change the way we think about education. Most teachers are not prepared for this change. There is another bill in Congress that should be used to integrate High Performance Computing and Communications into education. Part of this bill is to install a National Research and Education Network that will connect all schools by fiber-optic cable. This network will provide schools and teachers with access to electronic mail, network projects, and resources; it will revolutionize education. We need to prepare teachers to be experts and facilitators of this technology so that schools can take advantage of our information society.

Our observations in schools and a survey conducted in spring 1991 help us recognize some of the basic problems schools have in making the transition to an information society.

- Though computer hardware and software have been in schools for several years, teachers have had very little time to master the basic hardware and available software. The surveys indicate a lack of attempts to

implement technology into the curriculum and only basic administrative and personal use of software tools.
- Some teachers have had exposure to various software tools, but this exposure was too sporadic and insufficient to start an effective computing team in the school.
- Most of the teachers have reported that they are not comfortable using the available commercial software tools but that they are motivated to learn more and are willing to put effort in making it work for them and their classes.

The NCSA Living Lab also addresses the shortage of scientists in the United States. Students often do not pursue careers in science because they don't know about science career choices at the time they are making career choices. The NCSA Living Lab intends to enlighten young students with knowledge of scientists and what science is all about. Another consideration is that students who *are* interested in pursuing careers in science are usually unprepared at the college level. This means that colleges must teach basic science theories and concepts before new theories and technologies can be introduced. Currently, only students at the doctorate or post-doctorate level are learning about or experimenting with new technologies. Even many doctoral candidates are at the stage of only reading what has already been discovered, rather than experimenting with new theories. If we expect to maintain the current growth in computational technology, we must educate potential scientists in the current technology in order for these new scientists to build on the current base. If potential scientists are not prepared to carry on research that has begun, our high-tech world will stagnate.

If high technology is to become useful to the average citizen, then we must educate the average citizen in the use of high technologies, such as high performance computing technology (especially networking, communications, and scientific visualizations). If we teach the children of today, the adults of tomorrow will welcome, utilize, and even control, high technology.

Answering the Need

The NCSA Living Laboratory is designed to address these issues and prepare teachers and students for the changes needed in education. This project proposes to create a *computing environment* in the school—a computing culture built on a critical mass, so that each teacher has knowledgeable and interested peers, and the school's environment provides teachers and students with challenges and informal learning opportunities. The goals of the NCSA Living Laboratory are to:

- improve science and mathematics education for all students
- prepare students and teachers to use the National Research and Education Network for communication and collaborations with other teachers and schools
- provide opportunities for interested students and teachers to engage in special research or exploration projects using high performance computational technology, and
- develop a model for infusing schools with computational technology and for systematic evaluation of that infusion in such a way that successes can be shared nationally.

The Structure of the NCSA Living Lab

The NCSA Living Lab is modelled after NCSA's Education and Industrial Affiliates program. Since NCSA was established seven years ago, it has been extremely successful in the transfer of high performance computing expertise to the academic community in both research and undergraduate education. The model that made this possible is the one of affiliating institutions with NCSA. Affiliation requires the institution to make a commitment of personnel, one local resource person whom NCSA trains and supports at a level higher than can be offered to all users at that institution. This local resource person is an integral part of the institution's infrastructure who has developed special contacts with NCSA staff. In short, NCSA nurtures a champion chosen by the institution, who commits to help colleagues to diffuse knowledge and expertise throughout the institution. The institution's NCSA champion acts also as the institution's ombudsman with NCSA; communication and learning take place in both directions.

NCSA has used this model successfully, although without implementing all the aspects of a formal affiliation, in three local elementary and two local middle schools. NCSA's Living Laboratory places a science and/or education undergraduate student as the resource person in each participating school to be used at the discretion of the school principal. The resource person provides on-site help for teachers in learning to use computers, electronic communications and implementation of high performance computational technology into the curriculum. This experience has shown that having a resource person from NCSA accessible to teachers in their school building is as effective for elementary schools as NCSA affiliation is for institutions.

NCSA performs two roles for successful affiliates: it is (1) a technology interface and resource, and (2) a window to how other institutions work with NCSA. For affiliated universities, the second role—increasing peer contacts and information transfer—is just as important as the first one. It is expected that for K-12 schools, where isolation within a building, if not within individual classroom walls, is still the dominant paradigm, it will be even more important. That is one of the reasons why networking is such an integral part of NCSA's approach to school computer instruction. At the end of the project, school expertise and confidence will allow the affiliation with NCSA to continue, with one of the school's teacher champions as the new local resource.

A Total Computing Environment for Teachers

In addition to the affiliates in the schools, the NCSA Living Laboratory creates a total computing environment by encouraging after-school and summer activities for students and teachers. Harris and Anderson (1991) note that "the teacher is the key to successful infusion of computer innovations into K-12 education". They describe the teacher's role in instructional technology reform as dependent on time, access and training. Thurston (in press) found in her research with a school in the process of technology implementation and through a national survey that Support, Time, Access, Resources, and Training (START) are necessary for schools and teachers to successfully infuse instructional computing into the curriculum. Based on this evidence, the NCSA Living Lab has used START to incorporate several learning environments for the teachers.

Summer Workshops

The NCSA Living Lab focus on teachers began with a summer microcomputer workshop. The purpose of the workshop was personal and professional development of teacher/champions who were in the process of implementing a computer-based curriculum for High Performance Computing and Communication in their schools. We based the workshop on the dimensions and methods for in-service workshops outlined by Gall and Renchler (1985). *Readiness activities* included studying the state goals for technology education, talking with teachers and administrators, and observing classroom instruction. To ensure maximal success we based the agenda of the workshop on an interest and need survey. The *instructional process* was structured into short introductions with demonstration, followed by individual practice and coaching. We kept in mind that adults have generally lower tolerance for ambiguity and prefer informal learning environments which are less likely to produce tension and anxiety (Knowles, 1978). The *instruction* and demonstration part of the workshop was based on team-teaching. NCSA faculty and students (from the field of Education, Computer Science, or Engineering) participated in the preparation of materials and implementation of the workshop. We gave ample opportunity for practice and relied on the active role of participating teachers in pacing and scheduling the content and activities. The afternoons of each workshop day were open for teachers to come in for more practice, exploration or to develop curriculum materials for their classes. Interested teachers also had the opportunity to participate in the team teaching of a student workshop designed for 3rd and 4th grade students following the teachers' summer workshop.

The assessment of the workshop was done by survey and observation. We saw an increase in self-reported motivation and knowledge measured on a Likert scale. An interesting realization from the workshop was that teachers assign greater priority to learning those software tools and techniques that they have actually been exposed to in practice or their teaching peers have experienced. The teachers that participated in the workshop have also been more likely to bring their students to NCSA for a school visit to explore and practice with software tools unavailable at their school. Thus the workshops are not only singular events, but foster future activities with the Living Lab.

Seminars

Weekly seminars on "HPCC in Education" are offered for teachers to hear and discuss new ideas for classroom projects using their computers. These seminars feature top scientists, educators, and successful teachers in the area. Some topics that the teachers have found interesting and useful are:

- *Educational Uses of NCSA Videos.* (David Curtis, NCSA). Videotapes of chemistry, weather, and life science visualizations can be used to introduce science and motivate children of any age. In fact, in several cases when elementary school children were shown an NCSA video, the subject of the video, and the video itself, prompted many insightful questions about computers and technology.
- *Electronic Networking in K-12 Schools.* (J.A. Levin and Michael Waugh, UIUC College of Education). Teachers learned why networking is important, what telecommunications projects were available to them, and what each project had to offer for their students. Since that seminar more than 30 teachers have requested NCSA logins and more information about using Internet and FrEdmail.
- *Using SimEarth to Teach Science in Grades 3&4.* (Sheila Kirby, Leal Elementary School). Practical advice was given on how to one teacher used SimEarth successfully with nine-year olds. Since this seminar, many teachers have requested similar experiences for their classes.
- *Microburst Alert: Using Weather Visualizations to Teach.* (Bob Wilhemson, NCSA and Mohan Ramamurthy, UIUC Dept. of Atmospheric Sciences). Teachers learned how to access and visualize *current*

weather data. Data collection, visualization of data in a weather map format, and animation of the visualizations to detect weather patterns were demonstrated.

- *Getting Computers Into the Schools.* (Marilyn Sinclair, Franklin Middle School, and Hester Suggs, Washington Elementary School). Fundraising activities and grass roots movements to get computers were discussed.

While we don't know that the content of these seminars have increased the quality of science education, we do know that the seminars have motivated parents, school administrators, university faculty in the College of Education, and NCSA scientists to regularly attend these seminars. This has encouraged more diverse discussion and has enhanced the learning experience for the teachers. The seminars are beginning to become a part of many teachers' daily routine; this is what the computing environment is all about—the integration of constructive uses of successful computer technology into the classroom, slowly, but steadily. Further integration occurs when the seminar "regulars" bring colleagues to seminars, or even just disseminate in their school what they have learned at the seminars.

By observing attendance we also recognized that the order of seminar topics is important. It is crucial that the first few seminars in a series are popular with the teachers. What we deem to be important, although not necessarily interesting to teachers by title, can be presented later in the series. This gives teachers time to prepare for more advanced topics.

Workshops

As part of the Living Lab, weekly workshops are also offered during the school year for teachers interested in learning more about various topics related to educational uses of computers and telecommunications. Some topics have included Electronic Communications, *MicroSoft Works, Springboard Publisher II, Cricket Graph*, Desk Accessories, Fonts, Sounds, and NCSA Software Tools (used to communicate with Internet machines and visualize data). At each workshop an NCSA consultant demonstrates how to use the software and discusses how the software could be used in the classroom. Then the participants practice or explore on their own.

The success of the workshops is due mostly to the fact that there is a minimum of five NCSA consultants at each workshop to help the participants on an individual basis. This allows for significant attention to each teacher; and that is how the participants learn most efficiently.

Discussion of the educational uses of each piece of software is also important; in fact, just teaching the basics of the software could be destructive because the teachers might use it in the classroom without any focus or purpose. The students learning to press keys and use a mouse is all that is accomplished without a direction; focus will lead to the students using the computer as a tool, rather than as the subject of learning.

Providing Incentives

We have been in close contact with the local school districts regarding the coordination of our goals and objectives for instructional technology in schools. This communication is an essential part of the Living Lab success (Gall, Haisley, Baker & Perez, 1983). Besides providing centralized support and increasing the likelihood that the transfer of technology will continue once NCSA leaves the schools, teachers have received board credit for the workshops and seminars. Teachers are also sometimes given release time to participate in NCSA projects, or even paid outright.

Total Computing Environment for Students

Bauer (1991) predicts that the new age in education, the 1990s will be the era of discovery where teachers will be knowledge enablers, and specialists on how people interact with knowledge. In this next phase technology will assist teachers and help students by creating powerful environments for learning. "During this phase the three Rs will be replaced with the four Cs: Comprehension, Critical thinking, Communications, and Coping." The NCSA Living Laboratory takes this approach of providing a powerful environment for learning to teach and motivate students with science. We begin with K-2 students by teaching them how to use a computer and then allowing them to explore with some software designed for that age group; this promotes positive thinking about computers and science. The next step is to encourage grades 3-4 to think more logically and critically about science. There is also software designed to do just that. In 5th grade we can begin to teach basic science using a variety of software and special projects. By the time these students reach high school, they are ready to learn more advanced concepts, including using a supercomputer to analyze and visualize data. With all age groups we also encourage discussions about science and science careers by offering videotapes of NCSA visualizations and scientist activities. This environment of science education is supported by several Living Lab activities.

School Visits

Schools can visit NCSA for a tour of the supercomputers or to work in our lab of 20 Macintosh IIcx's. We work with each teacher to develop a productive experience at NCSA. Some of the more popular projects include:

- *Telecommunications.* With the help of Linda Delzeit of the National Public Telecomputing Network, an NCSA consultant prepared a scavenger hunt on the Cleveland Free-Net and also arranged for multinational chats. The students are able to talk to other students in California, Ohio, and Finland. Both activities are a great success and the students go back to school understanding the opportunities available on a large electronic network. Some teachers also asked for more information about how they could set up their own scavenger hunt and run it from their school.

- *SimEarth.* Before visiting, teachers are instructed to provide some class instruction regarding Earth atmosphere, geosphere, plant-life, animal life, and basic evolution theory. The minimum classroom activity would be going over terms used in *SimEarth* to describe various aspects of the Earth (e.g., biomes, trichordate, greenhouse effect). On the first class visit then, NCSA consultants teach students how to use *SimEarth.* The second stage is allowing the children to experiment with the Earth and the third stage is for the students to write a report expressing what was learned by playing *SimEarth.*

After-School Computer Exploration Days

After-School Computer Exploration Days are offered for students K-8 to visit NCSA to use our computers and software for special projects or just to explore. We announce several days available and divided the days by age groups. As with teacher workshops, there are always many NCSA consultants available; a minimum of one consultant per 3 children. This ratio allows the consultant to encourage educational uses of the simulations and games, as well as provide individual help. We have found that the students do ask critical questions that demonstrate a desire to learn more. The motivation for asking questions may sometimes be to become successful at their simulation game, but the fact remains that they are learning. What's more, the students are learning about and being motivated by science. While we won't know for quite some time that the motivation is successful in encouraging science careers, we know that if the students are motivated to ask science questions now, they are more likely to be motivated to learn and study science in the future.

The success of the Computer Exploration Days is somewhat mixed. The students that come love it, their parents love it, and we can see motivation to use computers and learn science. What we don't see, however, is enough students coming. The students who visit are often already motivated to use computers; the students that need motivation don't visit. Teachers have remarked that it is probably because parents work and transportation is too difficult to coordinate. The parents that have flexible schedules are usually teachers or professors at the university; and these are also the parents who have already encouraged their children to ask critical questions and to use computers. It is possible that a more thorough outreach program would be more successful; for example, if we could bring the computers to the students, we might see more success.

There have been a few isolated successes that are worth mentioning. One is that many parents stay with their children, especially parents of younger children. Often, the parents knew nothing about computers, so the parent and child learned together. In fact, several parents have asked for advice in buying a computer and computer software that would be fun but educational for their children. This kind of feedback from parents is always positive and if the Living Lab can motivate parents to make these decisions, then we can say it is a success. In another case, on one day when K-2 children were visiting and most had never used a computer before, one of the children who had access to a computer at home (as well as several older siblings) taught the other students to use KidPix. The student who taught enjoyed teaching and the other students thought it grand to be taught by one of their peers. This cooperative learning led to a highly motivated group that day.

Visualization Projects with Selected Groups

"Our school system has traditionally geared education to the left-brained analytic learner. .... Global learners thrive on getting the whole picture and then discovering the elements necessary to make up that picture." (Brennan,1982, p. 212)

One of our goals with having teachers and high school students work with us on visualization projects is to teach students and teachers how to use technology to visualize scientific concepts as a whole and at the same time see the components of the system.

One such project is aimed at improving teaching and learning of science in area schools by using visualization techniques available at NCSA. Visualization techniques are used for nondestructively sectioning organisms and tissues, imaging molecular bonding, and weather phenomena. Imaging techniques are used to build libraries of image databases. When such datasets are stored digitally, they can be explored using inexpensive image processing and display programs currently available for personal computers, and therefore can be used by teachers and students in the classroom.

The Future of the Living Lab

The success of the NCSA Living Lab is seen in the increased motivation and involvement of teachers in the total computing environment that NCSA has seeded. The number of teachers involved with the Living Lab has more than quadrupled and the number of total activities has multiplied ten-fold since its start. The model has been successful and the future of the NCSA Living Laboratory will be to train other institutions to build living labs of their own, to promote the methods used in the living lab in all schools, and to provide assistance to schools in achieving these goals.

Acknowledgements

The NCSA Living Laboratory is funded by a National Science Foundation Research Experiences for Undergraduates grant (NSF ASC 89-02829). Apple Corporation also donated 16 Macintosh computers for this project.

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A Leading-Edge Partnership

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Introduction

Beginning in 1992-93, Texas public schools will receive from the state a technology funding allotment specifically dedicated to improving productivity in schools through the use of high quality technology (The Texas Education Agency, 1991). At least 75% of this allotment is to be used to provide technology directly related to classroom instructional services and programs. To receive this funding, school districts must submit a five-year technology plan to the state, as well as annual end-of-year expenditure reports.

Many school districts in Texas have been engaged in long-term planning efforts aimed at improving student learning outcomes in their school districts. Some have not. But to receive the additional technology funding from the state, all districts must produce high quality planning documents reflecting their plans to integrate technology into their district's operation.

This is not a simple process. Effective planning is a time-consuming, complex endeavor, and even districts experienced in the planning process find it difficult to prepare the technology plans requested by the state. To assist them, the Texas Center for Educational Technology at the University of North Texas and the Apple Computer Corporation joined forces to present to Texas educators an interactive, multimedia planning tool, *Teaching, Learning, and Technology.*

Teaching, Learning, and Technology: What Is It?

The *Teaching, Learning, and Technology Interactive Planning Kit (TLT)* is an innovative multimedia-based information resource system and tool. It represents one of a new breed of second-generation productivity tools, combining vast amounts of video-, audio-, and text-based information resources with an extensive set of computer-based planning, presentation, and production tools (Pearlman, 1991).

The *TLT* creates a planning workstation that includes a videodisc, a CD-ROM disc, and a workbook used with a Macintosh LC or Macintosh II color system with at least 2 megabytes of RAM, a hard disk, and a videodisc player and monitor, and an AppleCD SC CD-ROM drive. The videodisc contains an hour of video clips and information on research-based curriculum and instructional practices that improve student performance. The CD-ROM contains the software necessary to access all audio, video, and text information.

Although the *TLT* is primarily designed as a planning guide, there are a variety of other uses for this kit. Community members and educators can browse through the *TLT* and explore what other schools and classrooms are doing. They can also use the video and audio *TLT* tutorials to enhance in-service sessions devoted to these topics. University professors responsible for training future teachers can use it not only as a tutorial on pertinent educational issues, but to model the way multimedia tools enhance the education process.

The content of the *TLT* is divided into two main sections. The "Planning Process" section takes the learner through the six major steps of the planning process:

1. Envisioning the Future—getting organized, glimpsing the possible, and creating the vision
2. Assessing Where You Are Now—gathering information, synthesizing the data
3. Setting Goals and Objectives—establishing the direction, stepping back, reflecting, and revising, communicating with others
4. Planning How to Get There—building the plan, creating the materials
5. Making the Plan Happen—getting approval, implementing the plan
6. Evaluating and Adjusting—evaluating the program, disseminating the program, keeping the vision dynamic.

The "Planning Process" section includes word processing capabilities—a text-based, interactive planbook that allows the ultimate planning document to be composed by the team as they are engaged in each step of the planning process. Templates or formats of each of the documents are provided and sample content is illustrated in red print. This allows the team to garner ideas from the sample documents that can be adapted to the unique planning needs of their group.

The "Teaching and Learning" section presents in-depth information on five topics of interest to educators:

1. Active Learning
2. Cooperative Learning
3. Interdisciplinary Learning
4. Individualized Learning
5. Teacher Professionalism.

Topical bibliographies with article summaries provide easy access to pertinent information. This section also includes nearly two hours of audio interviews ("radio interviews") and stories about how teachers and students successfully use technology. Actual classroom examples highlight important teaching and learning principles. Case studies of three successfully restructured school systems depict the impressive results that accrue when change is a result of thoughtful, proactive planning. Schools and teachers at New York City's School of the Future are depicted collaborating via computer-based telecommunications. High school students at Cincinnati Country Day School are shown doing mathematics for understanding. A learning-by-doing physics class in Palo Alto, California shows how computer simulations can bring physics principles to life. A glimpse of empowered teacher planners from Shoreham, Washington is provided.

When educators follow the *TLT* planning guide steps, the resulting plan will reflect a new generation of technology plans, plans that go beyond the student acquisition of computer-based skills and, instead, show how the school district can develop new modes of learning and teaching with the support of technology.

Technology Salesmanship

While the *TLT* acts as a multimedia planning tool, it also acts as a presentation tool. Writing an effective technology plan can be a useless endeavor, unless the plan is compelling enough to be bought by the school community. Too often effective plans are ineffectively presented and fail to receive school board support and funding.

The *TLT* is designed to assist the educational team to answer tough questions from school board and community members regarding costly technology investments embedded in their plan. It creates an impressive, multimedia presentation that not only captures the attention of the audience but provides tutorials on pertinent topics. The *TLT's* nearly two hours of video and audio clips and interviews can be selected, clipped and pasted so that each section of the planning document is highlighted by dynamic examples of teaching episodes and teacher interviews.

Questions received from the school board can be answered by accessing video examples of classrooms around the country. Instantly, the audience can see and hear examples of cooperative learning, interdisciplinary learning, and so on. Then, to demonstrate the role of technology in these classroom activities, the presentor can access pop-up screens showing what hardware and software were used in each specific application.

Using TLT in Texas

The Texas Center for Educational Technology at the University of North Texas in partnership with the Apple Computer Corporation conducted twenty workshops around the state to introduce key educational decision-makers to the *TLT* planning guide. Apple Computer Corporation provided their equipment and expertise for hands-on training opportunities. The TCET faculty provided a large store of school experience in planning for large and small technology projects within the educational environment.

Each day-long training session involved a team of three trainers. The training session opened by showing how the *TLT* planning guide interfaces with other commonly used planning tools. Although the *TLT can* be used as a stand-alone planning instrument, it was suggested that the planning process can be considerably enriched by weaving other planning processes into the total effort. Participants were then given a list of Texas technology planning resources such as the state-wide educational service centers and various arms of the Texas Education Agency.

The educators in these workshops then observed a trainer as they began a tour through the entire *TLT* kit. Participants then learned how to use the software and hardware that are integrated into the *TLT* kit by rolling up their sleeves and navigating through each section with guidance from the trainers. A "Scavenger Hunt" forced participants to find and use buttons and cards in various sections of the kit. After answering questions and concerns, participants were divided into cooperative learning teams and completed the training by creating actual plans for bogus school districts. Each team then shared their plan with the entire group. Participants not only learned about the many uses of the *TLT*, but gained a new measure of comfort in dealing with multimedia tools.

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Technology Needs in K-12: TCET Presents Its Latest Findings

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Abstract

The Texas Center for Educational Technology (TCET) is a non-profit organization established by the state of Texas. The poster session will present, discuss and demonstrate TCET's educational products and research findings. Poster session attendees will learn about the public-private partnerships TCET has developed and how TCET balances the private sector's objective to market products against the TCET's objective to disseminate information and tools to as wide an audience as possible.

The Texas Center for Educational Technology (TCET) was established in June, 1990, at the University of North Texas (UNT), with funding from the Texas Education Agency. The University of Texas (UT) at Austin and The University of Houston at Clear Lake (UHCL) are participating as a second- and third-site collaborators. Dr. Ken Brumbaugh is the Executive Director of TCET. TCET serves the Texas Education Agency, foundations, coalitions, community colleges, universities, professional organizations, businesses, and school districts that are involved in developing, distributing, and using educational technology.

TCET activities include research and development in the following areas:

- Applying new technology in educational settings,
- Creating prototypes for educational use of technology originally developed for commercial or other purposes,
- Researching the use of technology in education,
- Researching the use of technology for handicapped students and teachers.

TCET Activities, 1990-1991

TCET supported research and development at UNT and UT-Austin which made positive contributions to technology-based learning and teaching in Texas. In the 1990-1991 fiscal year, the laboratory activities and their objectives covered broad educational research needs. The titles and brief descriptions of the labs and research follow.

1. Assessment of Student Learning and Cognition—Studying human learning and learning activities; creating computer-based methods for diagnosing students' learning and cognitive processes.
2. Student Learning and Special Populations—Providing technological support of learning for learning disabled, physically disabled, mentally retarded, and emotionally disturbed.
3. Teacher Productivity and Training—Improving teacher effectiveness and efficiency in the classroom; using technology to free teachers to teach.
4. Teacher Retention and Support Networks—Using

technology to retain high-quality teachers in the teaching profession; facilitating communication between master teachers.

5. Curriculum and Instruction—Using technology in curriculum areas such as mathematics, science, reading, and social science.
6. Instructional Design and Evaluation—Studying instructional systems and their management in the public school environment to help implement technological systems and evaluate their effectiveness.
7. Educational Telecommunications and Informatics—Studying computer-based information exchange, telecommunications, and distance learning.
8. Multimedia and Emerging Delivery Systems—Studying ways to effectively integrate interactive multimedia into the classroom; evaluating emerging technologies and their application in education.
9. Design of Computer-Based Instruction—Designing interactive computer technologies in relation to individual differences among learners.
10. Brain-Mapping and Evoked Potential—Studying the biological basis of learning; studying learning disorders.
11. Collaborative Software Development —Using college student/classroom teacher pairs to produce instructional computing applications and utilities.

TCET Activities, 1990-1991

For the 1991-1992 fiscal year, TCET is instrumental in supporting research and development activities at UNT, UT-Austin, and UHCL. A list of the activities currently underway follows.

Activities at UNT

Research and development activities at UNT should result in several useful products for K-12 educators. Planned outcomes include:

- An ILS Assessment and Evaluation Kit,
- One or more "cookbook" school consulting packages,
- At least one videotape of a model technology-using school district,
- A report on using technology with special populations,
- The Children's Computer Inventory Handbook.

The four project areas being conducted by faculty at UNT are Curriculum and Instruction, Instructional Design and Evaluation, Student Learning and Special Populations, and Telecommunications and Informatics.

Curriculum and Instruction. The Curriculum and Instruction activities focus on using technology in curricula areas and to improve teaching. An assessment and evaluation kit for integrated learning systems has been developed to assist school districts in the task of selecting and evaluating the effectiveness of this popular technology. The kit should be available to Texas administrators and teachers in the Spring semester, 1992. Students in several school districts, including Dallas ISD, and young adults in the Texas State School system, are being assisted through curriculum and instruction research projects.

Instructional Design/Evaluation. A primary function of the Instructional Design and Evaluation research project is developing school consulting packages. Many schools in Texas and the U. S. need "cookbook" approaches to evaluating technology in education. TCET hopes these consulting packages will fill a support void now evident in education. One planned development is video tapes of model school districts who have successfully implemented educational technology.

Student Learning and Special Populations. Special populations are served by activities in the Student Learning and Special Populations research project. This year efforts will concentrate on studying applications of technology for the handicapped. TCET hopes to become a showcase for technological solutions in this important development area. With a new staff member having expertise in deaf education, avenues are being explored for ways in which TCET research and development can be targeted at this population.

Telecommunications/Informatics. The Telecommunications and Informatics research project is working to create a prototype that will allow educators to access TCET information and products through the Internet. The staff is also having English and Spanish versions of the Children's Computer Inventory Handbook validated. This is a practitioner's handbook which includes the Young Children's Computer Inventory, a questionnaire which measures attitudes toward computers, motivation, study habits, empathy, and creative tendencies in K-3 students. Connecting rural school districts via a fiber optics-based network is also under study.

Activities at UT-Austin

Dr. George Culp and Dr. DeLayne Hudspeth are leading two research efforts: (1) the development of teacher designed software, and (2) researching technology training needs for preservice and inservice teachers.

Teacher-Designed Software. Dr. George Culp's Collaborative Software Development research project at The University of Texas at Austin involves teachers and administrators from the Valley View and Highland Park elementary schools, and faculty and staff from the College of Education at UT-Austin. Teachers work with

UT faculty and graduate research assistants to design and develop HyperCard stacks to meet specific, defined classroom needs. The teachers provide content for the stacks plus a general design for the sequence of information. Stacks include documentation that tells the curriculum area, the targeted audience, purpose of the stack, educational objectives, instructions for use, and references or resources. After the teachers provide content and design, the research assistants develop the text layout, information sequencing links, graphics, animation, and/or music to present information to students in an interesting and informative way. The development team then tests the stacks and collaborates on needed revisions. This research project expects to complete at least six HyperCard stacks, four of them incorporating materials from Optical Data's Windows on Science videodisc series.

Exploring Preservice & Inservice Technology Training Needs. Dr. DeLayne Hudspeth's research project at UT-Austin will examine ways to improve skills and attitudes of new teachers toward classroom use of technology. The project plans to create an information resource for public school teachers and administrators that will describe and identify inservice training needed to use technology effectively in the classroom.

The resource will include:

1) A survey document detailing current efforts and programs used to prepare public school teachers in technology use,
2) Curriculum descriptions that reflect technology skills taught to new teachers, and
3) A report on the ways in which teacher-training institutions prepare new teachers to use technology in the classroom.

The problem is that each year new teachers enter the public schools without being adequately trained in the effective use of educational technology. Accordingly, this project will:

1) Examine and assess current efforts to prepare new teachers to use technology effectively,
2) Share ideas and resources for improving the technology skills of new teachers, and
3) Consider ways by which new teachers can generally become productive as soon as possible through the use of technology.

UHCL Activities

New ways of thinking, learning, and teaching. Those are the goals set by Dr. David Palumbo for his Advanced Knowledge Transfer (AKT) project at University of Houston-Clear Lake. As we move into the age of technology, a fundamental shift in education is needed which will focus on two essential attributes:

1) The ability to successfully interact with technology, and
2) The ability to use higher-level, critical thinking skills.

A good starting point would be to replace the ambiguous term "learning" with the more exact term "knowledge construction," defined as the process of assimilating and accommodating information in a way which builds explicitly upon the existing mental models that students already have. The research and development efforts of this project deal with a new learning environment based on knowledge construction and transfer, with a goal of developing new insights into how we teach, think, and learn. These new instructional environments draw on the rapid advances in computer technologies and new insights into cognitive science.

Two specific research activities are designed to explore higher-order thinking skills. First, the project will seek to assess the impact of various computer-based technologies upon promoting higher-order thinking skills. Research will focus on three specific computer applications associated with problem-solving: 1) computer simulations, 2) LEGO/Logo activities, and 3) using hypermedia. The project's work with these three applications will result in curriculum guides that support the use of those technologies. Centering on eight hours of instruction, each guide will be grade-level specific and provide objectives for daily lessons, relate the objectives to appropriate essential elements, and provide ideas for evaluation. A key component of each guide will be how to use the specific technology addressed.

Second, the project will explore a Hypermedia-Assisted Knowledge Construction System (HAKCS). This research activity seeks to determine if user-generated explicit semantics that are presented in a hypermedia environment can promote learning in a variety of content areas. Preliminary research in this area suggests that knowledge construction can be achieved by explicitly relating and connecting various nodes of information in long-term memory. The specific research activity presents a learner with a peripheral mental model constructed in computer-generated hypermedia. The learner is then challenged to correctly construct each of the expert-defined semantic relationships presented. The great potential of this part of the project is that it can help determine the impact that hypermedia could have upon knowledge construction-based learning environments.

Continuing operations at TCET include not only the basic research as described, but also a planned educator and corporation personnel exchange, the Technology Excellence (TEX) contest for educators, a quarterly newsletter, a Texas technology training tour, sessions at the Texas Computer Education Association annual meeting, summer teacher training institutes, and video and tele-conferencing. As the various research laboratories grow and produce their findings, products, and services, TCET will explore additional methods of dissemination to best serve all of its clientele.

MULTIMEDIA

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Multimedia applications have become a ubiquitous part of today's educational experience. While multimedia itself encompasses a wide range of activities and programs, this year's papers suggest that the most prevalent use of multimedia in education is in the area of interactive video instruction (IVI). The first article, by Troutman, Ivers, and Seifreit, serves as an introduction to the field. It describes various platforms, equipment and configurations for creating a multimedia development system.

Two of the articles that follow report the application of IVI to the psychomotor domain, particularly in the area of sports skills analysis, a difficult area of pre-service physical education teacher training. Stewart and Collier use frame-by-frame video analysis to show preservice teachers minute variations in sports actions, while Chung, Munson, Smith, and Phillips use the videodisc player to allow students to diagnose tennis errors that are otherwise difficult for novice instructors to identify. Both articles illustrate what can be done in a specialized area when knowledgeable subject-matter experts with expertise in teacher education apply their skills to the creation of technology-based instructional packages. There are two unfortunate things about these two studies. First, they are two examples of rare efforts to develop multimedia packages for teacher education. We should have hundreds of packages for a range of areas in teacher education, but today we have a few pioneers. Hopefully, they are the first generation of many packages for teacher education. Second, these packages are not available commercially. If you are an instructor interested in using these packages, there is no distribution system in place that helps developers connect with potential users of their work. Most of what we do in this field today is, unfortunately, available only for local consumption. We need inexpensive ways of distributing multimedia packages.

One encouraging sign in this field is the papers in this section. Although none of them describe a product that is commercially available today, several do describe IVI packages in use today to teach classroom methods to preservice teachers. Schick and Walker de Felix, for example, have developed model interactive video lessons for use with students with limited English proficiency along with a "teacher stack" that introduces preservice teachers to the use of interactive video lessons with students. Bosworth and Welsh present a system that helps teachers develop group process skills using a videodisc of real classroom teachers using those skills in interactive video. Meredith and Lotfipour apply interactive video to teaching cooperative learning methodology. Abate describes the development of a database combining textual information on teaching strategies with video demonstrations of the methods in action. Leavell describes the use of a cumulative video journal in which students can review their progress in microteaching

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presentations as well as the written commentary of their instructors and peers. Though Leavell's system is not computer-controlled, it facilitates preservice teachers' awareness of their own use of the methodologies they have learned. Campos describes an approach to introducing interactive video to teachers.

Other articles describe the development of programs showing preservice teachers how to take multimedia to the classroom as a student activity, where students participate in the creation of multimedia programs that actively aid their own construction of knowledge. Smyth describes a project involving a collaboration between business and education to use multimedia for improving science instruction. Bauer is concerned with making sure the preservice teacher is favorably disposed toward using multimedia in the classroom, and presents a general methodology for the development of technology-based classroom activities.

The topic of two papers might best be described as the "technical infrastructure" that facilitates the use of multimedia in the classroom. Jafari details the design and development of teaching environments, both fixed and portable, that support multimedia use by university instructors who are not necessarily multimedia experts. Miller's paper describes the development of a piece of software that uses the barcode capability of laserdisc players, that simplifies the process of creating lectures/presentations/demonstrations that use video clips stored on a videodisc.

The final group of articles extends the boundaries of what is traditionally considered multimedia. Vila and Ahlers describe an interactive multimedia system for helping instructors teach language and communication skills to the hearing impaired. Campbell, Bruning, and Nickerson describe a unique, two-way interactive television system for inservice teacher training. Finally, Bardo and Vigil show how a university can successfully obtain public and private funding to develop a support system, including a special building, for ground-breaking teacher education programs.

Multimedia: Models for Educators

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Abstract

Technical electronic devices with wide application are becoming increasing available to educators at affordable prices. Equipment for producing sound, video, and graphics that was affordable only by large corporations a few years ago is making its way onto the shelves of discount warehouses, mall shops, and local computer stores. Equipment is now available to university and school personnel who wish to build multimedia systems for the production of innovative educational products. Combined with human ingenuity, these systems have the potential to redefine the tools for delivering instruction. As with all technological innovations, an investment of time is required. This investment includes finding ways to interface hardware and software to construct optimal systems, and defining human skills necessary for driving these systems. Thus, the complex questions facing university and school personnel wishing to use multimedia systems include the type of electronic system desired, the pedagogical products to be produced, and the technical considerations related to purchasing pieces of software and hardware necessary for building an efficient multimedia system. The purpose of this paper is to address some of these questions.

The new buzzword in educational computing is multimedia. Like many terms, the word is overused and communicates a variety of messages. For most educators, the multimedia phenomenon is vague and confusing. Commercial entities attach the word to many products that may be appealing or have pizzazz, but lack instructional substance. Schools are often sold on canned or pre-made multimedia packages, requiring educators to fit their curriculum around the product, rely on the pedagogical expertise of the designer, or search for the nebulous product that conveys exactly what the educator wants. Similar to other technological advances in the past, there is the danger of overworking such a global term without carefully exploring the phenomenon and what it entails. This paper describes basic terminology for multimedia and presents a variety of platform configurations to fit various needs and budgets.

What is Multimedia and How Can Teachers Take Ownership of Multimedia Productions?

When we talk about multimedia in education, we are talking about one of two things:

1. Educators using computers and software to integrate a variety of media to produce educational products, or
2. Educators using multimedia products.

Multimedia products are created by using computer hardware and software to capture and integrate media such as text, graphics, sound, video, and photographs, to produce a presentation or interactive lesson (productions) that can be used over and over again. Productions can take many forms and can be played back on the computer that produced it or on a simpler platform, such as another computer or a playback unit of some type.

Several features should be considered when building a multimedia system, including available resources, what kinds of products you wish to design, and the desired mode of delivery—disk, cartridge, or videotape. You must choose the system you will use to create your productions, as well as the least expensive equipment required to run your productions. High-end systems are good for integrating and creating a diverse mixture of media, but care must be taken that your final product can be played on low-end systems. It makes no sense to design an elaborate production that few can use because of unique or expensive system requirements. Producing multimedia productions on low- end systems may have some limitations, but advantages include less restrictive requirements for playback.

Whether you opt for a high- or a low-end system, you need answers to three sets of questions:

1. What are the elements of input? What hardware, software, cables, and connectors are needed to send these elements to a computer? In what form are these elements stored in the computer?
2. How will the elements be manipulated or integrated to design your production? What attributes must your software tools support?
3. Will your production be a presentation or an interactive lesson? How will your final production be captured so it can be re-used?

Elements of Media

The basic elements of media are sounds and images. There are several possibilities for both, all of which have positive and negative aspects.

Sounds

Digital sound is recorded in a form that a computer can recognize, store, and manipulate. Recording digital sound requires a piece of hardware (capture board), a special software program (driver), and a microphone. Benefits of digitized sound are ease of recording and editing, that any sound can be digitized, and the tools for digitizing sound are fairly inexpensive. A negative aspect is that quality digitized sound requires a large amount of memory. In the hands of a skilled instructional designer, however, a few sounds will go a long way in creating effective productions. When acquiring hardware and software for digitizing sound, you should be sure that sounds can be saved in a form other software tools can access.

A MIDI (Musical Instrument Digital Interface) is a device that will transfer musical data back and forth from one MIDI instrument to another MIDI instrument or to a computer. With appropriate software, the musical data can be edited and saved in a computer file for playback on a MIDI instrument, or through a MIDI music card installed inside your computer. Authoring software tools that support MIDI music can be used to send sequences of music to a keyboard as it runs a production. MIDI music requires less memory than digital sound, and programs are available that allow you to create your own MIDI compositions. Music files can also be purchased. MIDI music can greatly enhance productions, but does require additional skill and equipment.

Images

Photographs, line drawings, text, or video images can be sent to a computer in digitized form through a scanner or a video source with additional hardware or software. A good scanner will let you access many sources, such pictures from magazines and books, text, or textures from materials like cloth or leaves. A scanner's software driver should allow you to specify resolution, image size, image type, the number of grey or color levels, contrast, and brightness. The best drivers are those that can be manipulated by other, more sophisticated programs.

Video sources include camcorders, video tape players (VTPs), and videodisc players. The format for a video source is generally NTSC (National Television System Committee standard), while computers use the RGB (Red, Green, Blue) format. There are several techniques for transforming NTSC to RGB. Hardware devices called video digitizers digitize a signal directly from a video source, but since video plays at 30 screens per second, it is difficult to obtain a computer image that is not blurred or distorted. If the source is a VTP, videodisc player, or camcorder, the source must have a quality freeze frame feature. The best sources for digitizing are still video cameras, which are small, lightweight, and very transportable. They have a built-in flash so that in most instances, light is not a major problem.

The best way to capture a real-time frame is through a frame grabber, which captures a video frame in 1/30 of a second and displays it through the computer's video board. This image can then be manipulated with a computer paint or animation program and saved in a computer file.

Video motion boards can display full motion video on your computer's monitor or access the video one frame at a time. Full-motion video cannot be treated as a computer graphic, so it is not possible to modify images using computer graphic tools. Although the video appears on your monitor, it actually plays through components which are separate from the computer's video board. Though computer graphics from the computer's video board can be overlaid with images from the video motion board to create interesting sequences, it is important to remember that computer graphics and motion video are separate signals played simultaneously on the monitor.

To record output from the computer's video board and from some motion boards you need a hardware component that changes RGB format back to NTSC. It must be able to communicate with the video motion component and should support a feature called genlocking, which synchronizes computer graphics with motion video as they are recorded to an output device, such as a videocassette recorder (VCR). The optimum piece of equipment would be a single hardware device combining video motion, frame grabbing, and output with genlocking.

Features to look for when purchasing a camcorder are a power zoom lens, multiple-speed shutter, flying erase head, rechargeable battery, and NTSC video output. NTSC video input and output is also necessary for VCRs, VTPs, and videodisc players, while an RS-232 connector is required for controlling a videodisc player.

Manipulating and Integrating Input

Once images and sound elements are acquired, they can be modified and merged to create unique productions. Two separate types of software are required, although both may come in a single package. First, you need software that allows you to modify images and sounds to create video sequences. Attributes to consider are full-featured painting and animation, automatically animated text graphics, scripting or linking for interactive productions, and prerecorded sound and music.

Second, you need software that allows mixing—the simultaneous playing of several sequences. Mixing software is a multimedia "layout" program that allows you to arrange sounds, images, and video for playback or recording of your production. If your final production is to be played back on a computer other than the development system, your development software should come with a free or inexpensive run-time module, which allows you to distribute and play your production without the presence of the development software on the playback machine.

Producing the Final Product

The third set of questions deal with what, initially, should be your first question when undertaking the design of a multimedia production: What form will the final product take? Specifying your final product is an important issue because it dictates what your elements of input will be, how you get that input, and what hardware and software is necessary to capture and manipulate the input. Also, deciding on your final product tells you whether the design of your lesson is for presentation purposes (a video) or interactive purposes (a disk or cartridge). Videos have the advantage of reaching larger audiences because of their less restricted playback environment, and can be made semi-interactive with the appropriate storyline and creation of additional teaching materials.

Interactive productions allow users to become more involved with the presentation, providing non-linear exploration and self-paced learning. If you want to limit your production to a single floppy disk, you will be limited in the amount or size of digitized sounds or images that can be included. High capacity, removable, disk cartridges might be considered for productions requiring lots of memory.

Multimedia Models for Education

Instead of opting for slick, show-off systems that can only be used by a select group of skilled educators, we feel it is often better to have systems students and teachers can use to design their own productions. We feel strongly that the instructional computing movement should involve

Chart 1: Low-end Development Platform
From $2000.00 to $4500.00

Computer System	386sx-20Mhz., 2 MB RAM, VGA monitor
MIDI Music/Sound Digitizer	Sound Blaster Pro from Creative Labs
Earphones or Speakers	
Frame Grabber	ComputerEyes/RT from Digital Vision
Still video camera	ZapShot from Cannon
Flat bed scanner*	ScanJet IIc (Hewlett Packard) & software
Development software	Storyboard Live from IBM

**optional*

Chart 2: High-end Development Platform
From $12,000.00 to $15,000.00

Computer System	Macintosh IIci, 16 MB RAM, 13" Hi-Res RGB Monitor
Sound	MacRecorder 2.0 from Farallon Computing
Music	CD-ROM drive that will play music CDs
Input Device	Hi-8 Camcorder (LanC)
Mastering Unit	Hi-8 VCR/4-head (LanC)
19" Monitor	
Video Board	NuVista+ from TrueVision
Flat Bed Scanner	LaCie from Lacie Limited
Videodisc Player	Pioneer 2200 from Pioneer
Audio Mixer w/microphone	
MIDI Adapter*	
MIDI Musical Output*	Sound Canvas SC-55 from Roland
Animation/Paint Software	Director from Micromind
Mixing Software	Media Maker from Micromind
Music Program*	Performer from Mark of the Unicorn

*optional

teachers and students using technology to create their own learning tools. To date, the instructional computing movement has not sufficiently shifted away from the notion that learning comes in prepackaged pieces that teacher use and students consume. Too many of education's meager resources are drained away by costly systems that deliver impersonal and mediocre instruction.

In what follows, we describe two multimedia platforms. The first is a low-end system that can easily be used by a motivated group of teachers or students. The second is a higher-end system with broader applications that has a steeper learning curve. Both can be used to produce valuable systems, where learning results from the process of creating the production as well as from the production itself. We recognize that pricing and technological specifications will change rapidly over time.

The first platform is for the MS-DOS environment. We recommend this platform because it is fairly powerful as well as relatively inexpensive. Colorful interactive productions can be created that will run from a high density diskette or hard drive. This system can be made available to many teachers or students. With good planning, cooperative groups can be formed to design productions on a single platform. This system involves the equipment and software in Chart 1.

This system can be used to design interactive productions with 256 colors. With Storyboard Live, animated text or characters called sprites can be created to add zip to your productions. MIDI music and digitized sound can be easily integrated into presentations. Storyboard also has a paint feature that can load PCX files. This means that it can access graphic files that are produced using a scanner or frame grabber. Images can be incorporated from a VCR, a still video camera, or from use of a scanner. Once these files are loaded, they can be doctored using the paint feature. A simple editing component weaves these elements together. To top it off, there is a free run-time module that allows you to distribute your production to those who do not have Storyboard.

The down side of this developmental platform is that it will not produce output on videotape and cannot be used to produce real-time animation sequences. However, it is easy to use and has tremendous potential for both teacher and student use.

Chart 2 is a description of a higher-end system that runs on machines in the Macintosh II family. This platform will do almost everything the low-end system will do, with the added features of smooth animation and the ability to send your production to videotape.

Very sophisticated productions can be developed with this system. The animation software has a scripting language that allows you to build interactive modules. The animation feature has full paint capabilities and allows you to build layers of animation that can be played simultaneously. With the mixing software, you can control external video, music, computer animations, and sound as they are sent to a VCR for recording. An ample supply of music can be provided by the CD-ROM drive. With the MIDI equipment and software, you can compose, import, and record original music. The audio mixer allows you to combine MIDI music, voice, and CD music to produce recorded sound tracks for your production. This system is very exciting and opens doors to education that have never been opened before. It requires a few people with new ideas to step through these doors to bring life to our educational system. As we see it, these systems should be used in group projects where students and teachers produce materials for each other.

In Closing

The availability of technical electronic devices with wide application are becoming increasing available to educators at affordable prices. Equipment for producing sound, video, and graphics that was affordable only by large corporations a few years ago is making its way onto the shelves of discount warehouses, mall shops, and local computer stores. Equipment is now available to university and school personnel who wish to build multimedia systems for the production of innovative educational products. Combined with human ingenuity, these systems have the potential to redefine the tools for delivering instruction. Common to all technological innovations, an investment of time is required. This investment includes researching ways to interface hardware and software to construct optimal systems, and defining human skills necessary for driving these systems. Thus, complex questions facing university and school personnel wishing to use multimedia systems deal with what kind of electronic system is desired, what pedagogical products are to be produced, and what technical considerations are related to purchasing pieces of software and hardware necessary for building an efficient multimedia system.

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An Interactive Video Tape Program Designed for Preservice Teacher Education

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Abstract

Sport skill analysis refers to the analysis, diagnosis, and prescription of sport performance. The environment, technical skills, and amount of content make teaching sport skill analysis a genuine challenge. The benefits of interactive video instruction —learner control of content, sequence and pace, ability to give immediate feedback, flexibility, and time and cost efficiency—make its use in undergraduate instruction a viable alternative. *Analyzing Volleyball Fundamentals* incorporates these benefits into an interactive video tape instructional program that teaches skill analysis to preservice physical education teachers. Program content and design features address problems associated with traditional instructional methods. Information gleaned from the design and formative evaluation will contribute to the improvement of physical education teacher education, as well as provide useful information about the uses of interactive video as an instructional medium.

Concerns expressed by teacher educators related to training preservice teachers include inadequate time (Cruickshank, 1991), varieties of teaching and learning styles (Mosston, 1966), inappropriately paced instruction (Seal-Wanner, 1988), technical complexity (O'Sullivan, Stroot, Tannehill, & Chou, 1989), and a vast amount of information to be presented (Cruickshank, 1991). Traditional instructional methods have done little to address these problems. An alternative instructional method gaining attention in education involves the use of interactive video technology for individualized preservice teacher training. An appropriate interactive video tape instructional program has the potential to address many of these problems. Promising results have been reported in the field of physical education (Kellers, 1989; O'Sullivan, et al., 1989, Patrick & McKenna, 1986; Walkley & Kelly, 1986).

Benefits of interactive video instruction as reported in the literature include: learner control of instruction, sequence and pace (Seal-Wanner, 1988), immediate learner feedback (Melloni, 1986), varied interaction techniques to accommodate diverse learning styles (Cambre, 1991), the flexibility to be used in large group, small group, or individualized instruction (Cambre, 1991), and time and cost efficiency (Glenn, Kozen, & Pollak, 1984).

Rationale

Sport skill analysis, which refers to the analysis, diagnosis, and prescription of sport performance (Hoffman, 1974), is difficult to teach. The complex environment, technical intricacies of skills, and myriad of skills to be taught make teaching sport skill analysis a genuine challenge. Traditionally, preservice teachers are taught skill analysis techniques in a classroom setting. They are asked to memorize critical elements or to technically analyze performances in a biomechanics laboratory (Tannehill, O'Sullivan, Stroot, & Livingston, 1991). Each of these methods has drawbacks related to practicality and effectiveness (Hoffman, 1974).

The benefits of interactive video instruction are well documented in the general teacher education literature (Bosco, 1986; Smith, 1987). These findings have led to an examination of its possible uses in teaching sport skill analysis. Walkley & Kelly (1988) examined the issues of teacher dependency and time efficiency. They concluded that interactive video instruction was less teacher dependent and more time efficient than other methods. Tannehill, et al. (1991) found that although interactive video technology has yet to be shown more effective than other instructional formats in physical education, other advantages may encourage its use. These advantages are individualization, immediate feedback, and cost effectiveness.

The need for further research on the potential benefits of interactive video instruction prompted the designers of *Analyzing Volleyball Fundamentals* to develop and analyze their program with hopes of contributing to quality teacher education and providing a greater understanding of the potential uses of interactive video as an instructional medium.

Instructional Design

Analyzing Volleyball Fundamentals is an interactive video tape instructional program based on the Kent State Skill Analysis Model (Pettigrew, Moore, Becher, & Livingston, 1990). Preservice physical education teachers enter the program with requisite knowledge of biomechanical principles, basic movement concepts, and critical elements of volleyball sport skills. These entry level behaviors are addressed in a skill analysis course and a volleyball course prior to using this program.

Exploring the Program

Analyzing Volleyball Fundamentals begins with an exploration segment that allows preservice teachers to become familiar with program features and understand the intended program progression.

Pre-test

The purpose of the pre-test is to determine if preservice teachers possess the requisite behaviors described above. The program is designed to inform preservice teachers whether or not they reached mastery level. If the pre-test was mastered, they begin the instructional segments. If mastery was not reached, they are instructed to complete a remediation segment.

Remediation

The remediation segment of the program is designed to clarify and reinforce entry level behaviors. A series of narrated video segments take preservice teachers through an entire skill sequence, highlighting the critical elements and common errors related to specific volleyball sport skills. The remediation segment is accessible at any time during the program, allowing preservice teachers the option to review skills as they deem necessary.

Level One

This segment of the program is the first instructional activity. Level One encourages maximum student interaction through a visual format. Students interact with the media by examining video clips, answering questions, and receiving feedback based on their responses. This segment encourages preservice teachers to use existing knowledge of skill analysis to correctly answer questions. Students are guided by cue and review techniques.

Level Two

Since providing feedback to the learner is a major part of teaching, Level Two was specifically designed to provide preservice teachers with an opportunity to give corrective feedback in a hypothetical situation. Initially, preservice teachers are given prompts, or cue words, to help them organize their responses. As they progress through the segment, fewer cues are given, allowing the preservice teachers to develop their own responses.

Since assessing preservice teacher responses is vitally important to teaching skill analysis, students may print feedback for review. These printouts are assessed by the course instructor and utilized for in-class discussions.

Features of the Software

Questioning Strategies

Analyzing Volleyball Fundamentals contains information to be learned by preservice teachers that can be classified as intellectual skills (Salisbury, 1988). The general structure and flow of Level One drills are as follows: learner selects subskill group from a menu, video clip is viewed, randomly selected questions are presented, learner enters a response, response is judged, and feedback is presented. Random selection of questions was incorporated to minimize memorization of answers associated with sequential questioning strategies.

Glossary

A glossary is provided for learner convenience. Since many terms used in *Analyzing Volleyball Fundamentals* may be new to the learner, this feature enables them to click on highlighted terms and receive operational definitions, and in some cases, an example of the term. The glossary is used to facilitate understanding of terms specific to the skill analysis process.

Notebook

Learning is an active process in which learners generate meaning for information by accessing and applying existing knowledge (Sailsbury, 1988). Generative learning strategies (recall, integration, organization, and elaboration) are used in the notebook design at Level Two to encourage the connection of existing knowledge structures and newly presented material. The learner is asked to recall relevant information, integrate existing and new information, organize the two, and elaborate on them by generating an appropriate feedback response. Information contained in the notebook is stored and printed.

Feedback

The type of feedback provided to the learner is contingent on the purpose of the drill. In the pre-test segment where factual information is being tested, learners need only be told the correct answer as feedback for an incorrect response (Sailsbury, 1988). During Level One instruction, where intellectual skills are presented, more informative forms of feedback are used. For example, the learner is told why a response is incorrect and a restatement of the concept is provided.

Learner Control

Given the content of the program, maximizing learner control of the program was a difficult issue to address. Since mastery of Level One is important before progressing to Level Two, a certain amount of learner control was sacrificed. Areas where learner control was maximized are described below.

- **Content.** During remediation in Level One and Level Two, the learner can elect to review objectives and choose the order in which they examine skills (forearm pass, overhead set, or underhand serve). The learner may also opt to review the remediation segment of the program at any time.
- **Video.** To facilitate transfer of learning to real life settings, presentation of video segments are viewed with no learner control. However, if the learner enters an incorrect response to a question following a video segment, they will be given control of the video functions for review purposes. This strategy should encourage learning that can be transferred to real life, while allowing remediation until a real-time level of proficiency is reached. Learner control of video segments is also exemplified by their ability to view video segments numerous times before continuing.

Conclusion

Although this program is still in the formative evaluation stage, the instructional designers are confident that information gleaned from its development will contribute to the improvement of physical education teacher education instruction. Program designers encourage teacher educators in other content specialty areas to continue exploring the uses of interactive video technology to enhance the quality of all undergraduate teacher education programs.

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Effectiveness of Interactive Video on Tennis Skill Analysis

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Abstract

A physical education teacher's ability to analyze students' correct motor skill patterns is a crucial aspect of effective physical education teaching. Providing effective training of psychomotor skill analysis in teacher education programs in physical education is recognized as a difficult and demanding task. Investigating the effectiveness of interactive video instruction is to suggest an innovative method of teaching prospective teachers to develop skill analysis competency. This paper describes a technological intervention designed to make the task less difficult. The motor skill set targeted in this project is tennis. Because tennis skills are complex and occur too rapidly to be easily identified in real time, level III interactive videodisc was selected as an approach that could overcome some of the problems in learning to diagnose errors.

Motor skill analysis is a difficult and complex skill for preservice physical educators to master. This paper describes a technological intervention designed to make the task less difficult. The motor skill set targeted in this project is tennis. Because tennis skills are complex and occur too rapidly to be easily identified in real time, Level III interactive videodisc use was selected as an approach that could overcome some of the problems in learning to diagnose errors.

Interactive video mixes computer control with videotape or videodisc instruction. Typical components of an interactive video system include a PC with optional peripheral devices, a video player (tape or disc), an interface connecting the computer and the video player, a video program, and computer software that includes an instructional program and controls for the video player.

Interactive video systems have been used for more than 10 years with remarkable results. By meshing the computer's data management power with the sensory experience of television, interactive video produces a phenomena that can be used to effectively improve the learning process as well (Miller, 1990).

Different degrees of interactivity are produced by different hardware and/or differing combinations of hardware. Daynes and Butler (1984) have identified five levels:

- Level 0: Linear playback only. The user starts and stops the lesson but does not otherwise interact with the machinery during its course.
- Level I: Adds frame-accurate access. The user may control the speed, direction, and search-and-scan capabilities of the video player.
- Level II: Provides Level I features as well as faster access, increased machine durability, a built-in port for microcomputer interface, and an onboard microprocessor and memory.

- Level III: Provides a Level II machine connected to a microcomputer.
- Level IV: A theoretical level at which anything is possible.

Development of the Tennis Videodisc Program

As with any instructional method, the effectiveness of interactive video is dependant upon the quality of its design. Well-designed instruction motivates the learner, effectively communicates objectives, organizes the learning experience, provides adequate practice and feedback, and encourages skill transfer (Gagne & Briggs, 1979).

Since little research on the effectiveness of using interactive video to teach motor skill analysis has been conducted, the purpose of this project was to first design an instructional application using this platform and based on sound pedagogy, and, secondly, to test its effectiveness in teaching competency in tennis skill analysis.

The process used to ensure the merit of the *Tennis Skill Analysis* (1991) interactive video program involved the four phase model delineated by Hannafin and Peck (1988). The phases are needs assessment, design, development and implementation, and evaluation and revision. A collaborative development team consisting of tennis content experts, instructional designers, video production technicians, and programming consultants was employed.

Phase One - Needs Assessment

During the needs assessment phase, characteristics of the students, environment, and constraints surrounding the project were explored in order to generate an appropriate project goal and several accompanying objectives.

The target student population is preservice physical education teachers enrolled in the teacher training program at the University of Northern Colorado. Before the interactive video instruction was implemented, students were required to take an Analysis of Movement of Racket Sports class delivered in the traditional classroom lecture/demonstration manner. The goal for interactive video instruction is identified as follows:

Using an interactive video medium the student will identify correct and incorrect components of the four basic tennis strokes: forehand, backhand, volley, and service. This goal can be broken down into two specific objectives:

1. The student will identify correct stroke components relating to racket alignment, body positioning and stroke execution in the four basic tennis strokes.
2. The student will identify incorrect stroke components relating to racket alignment, body positioning and stroke execution in the four basic tennis strokes when the errors are executed individually and in pairs.

Phase Two - Design

After completing the needs assessment, the design phase began. The sequencing of objectives was determined and the lesson was flow-charted and storyboarded. Principles of screen design protocol proposed by Hannafin and Peck (1988) were used.

Phase Three - Development and Implementation

The activities in the third phase, development and implementation, changed the program from a plan on paper into the tangible product. Activities included shooting and editing videotape, programming, and testing and debugging. All specific shots were edited together with no transitions, since transitions are not necessary in a Level 3 interactive video application. Using the storyboard as a guideline, programming began while the video was in production. Final programming could not be completed until after the videodisc was pressed.

Phase Four - Evaluation and Revision

Two methods of formative evaluation were conducted during development to examine the instructional, cosmetic, program, and curriculum adequacy of the program. The instructional designer consulted with each team member to identify solutions to problems encountered in the design process. Small group presentations to students, team members, and interested individuals provided further useful information. Results of this ongoing evaluation process shaped the project development and guided appropriate revisions.

Interactive Video for Teaching Competency in Tennis Skill Analysis

The incorporation of interactive video technology into the tennis theory class for preservice Physical Education majors at UNC has led to two improvements. The acquisition of skill analysis knowledge and the necessary practice required to obtain competency occur outside of regular class time. The self-paced program allows students with different entrance skills to proceed at their own rate. Additionally, students can assess their own competencies, and once they reach the acceptable standard established by the course instructor, they can choose to terminate their work or continue to improve their skills.

Because the time consuming instructional task has been removed from the scheduled class time, the instructor has additional time to teach pedagogical content knowledge specific to tennis. With more time for teaching skills in the classroom, and with skill analysis assured through the interactive video program, students who leave the physical education teacher education program at UNC will be better prepared to teach tennis than they would have been under previous teacher preparation strategies.

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Using Technology to Assist Language-minority Students and Preservice Teachers

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Abstract

In an attempt to meet the challenges of increasingly diverse school populations and increased limitations on methods instruction for preservice teachers, the Bilingual Training, Development, and Improvement Project at the University of Houston has developed five interactive video modules for linguistic-minority students. Commercial videodiscs were repurposed using *HyperCard*, and the modules were field-tested on fourth and fifth graders in inner-city schools. Results from content and language measures indicated that students showed significant gains after viewing the modules. Students also responded favorably to the technology on attitude surveys. An interactive video program designed to inform preservice teachers of the needs of linguistic-minority students was also developed.

In 1983, the National Commission on Excellence in Education released its report, *A Nation at Risk*, which described the "alarming condition" of the educational system in the U.S. and called for sweeping reforms at all levels of education. One of the results of these recent reform efforts has been a shift of leadership for the education of teachers from schools of education to state educational agencies, school districts, and/or Colleges of Arts and Sciences. In Texas, for example, the academic program for elementary teachers was drastically altered by the state legislature. Beginning in 1990, elementary teachers could take no more than six semester hours of methodology courses; previously they had taken at least 15 hours of content methodology. The change required that teacher educators develop innovative programs.

In addition to reforms in teacher education, many of the problems cited in *A Nation at Risk* reflected concerns related to a growing linguistically diverse population. In recent years, the American education system has in fact witnessed the development of a variety of programs designed to meet the linguistic and academic needs of an increasing number of immigrant children who do not speak English well. Although bilingual and English as a second language (ESL) classes are intended to provide these students with the language skills they will require to function in mainstream classrooms, many non-native speakers do not have the benefit of such programs or are exited before they have acquired the language and concepts they need to achieve at appropriate grade levels. These students are therefore faced with the enormous task of developing academic concepts in a language which may be unintelligible. Given the rapid rise in the number of minority students in the U.S. education system, it has become increasingly important for educators to find effective means of meeting the needs of this special population.

The University of Houston proposed to meet this challenge of preparing teachers to work with an increasingly more diverse student population, within the guidelines of the most limited elementary education program in the country, by retraining faculty and using technology. In this way, classroom teachers faced with the failure of traditional means to meet the needs of a growing linguistic-minority population might find new methods of instruction that would provide these at-risk students with the academic tools they need to succeed within the American education system.

Conceptual Framework

Computer-Assisted Instruction

Technological advances, such as computer-assisted interactive video (CAIV), may prove helpful in creating the contextually-rich learning environments necessary to facilitate the successful acquisition of both language and content area objectives by linguistic-minority students. Features such as the added contextualization of video images provide linguistic-minority students with important links to first language (L1) concepts. In addition, L1 and second language (L2) support may be incorporated into the programs by means of digitized speech, dual audio tracks on laser discs, or multimedia glossaries (Hasselbring, Goin, & Wissick, 1989). Furthermore, CAIV also shares important features common to other computer-assisted instruction (CAI), such as immediate personalized feedback and the options of individual or group learning and student or computer control. Such educational innovations may provide more appropriate learning contexts for linguistic-minority students.

The current rate of failure among this population underscores the need for new and effective instructional systems that will assist linguistic-minority students in the achievement of academic, linguistic, and personal goals. Recent research in areas of second language acquisition and instruction suggests that second language learning is most effective when meaningful contexts are provided (Cummins, 1986; Milk, 1990). These findings concur with more general research in cognition and learning that supports the use of situated cognition or authentic learning environments in order to promote the appropriate integration of language and concepts into long-term memory so that they can later be accessed and the information retrieved and applied to problem-solving situations (Bransford, Sherwood, & Hasselbring, 1988; Brown, Collins, & Duguid, 1989).

CAIV can enhance the development of such cognitive processes by providing an effective mediated instructional environment for linguistic-minority students. Hasselbring, Goin, and Wissick (1989) first describe the benefits of mediated instruction in a more traditional setting in which the teacher as mediator arranges the learning experience so as to emphasize essential concepts and link them to the students' prior knowledge. "Without a mediator arranging the situation for the student to encounter the important concepts and then linking these concepts to existing experiences and knowledge, the knowledge often remains inert" (p. 62). Inert knowledge here refers to information that has been presented to the students as facts in isolation and is subsequently stored as such. Hasselbring et al. (1989) argue that information not presented within a context that is meaningful to the student is not available later for problem solving.

Whereas teachers normally assist students in relating new information to previously presented concepts, teachers of linguistic-minority children are often unfamiliar with the language and cultural background of their students, and are thus unable to make these necessary connections. In the case of CAIV instruction, the computer would supply the mediation normally provided by the teacher so as to ensure successful language and content learning for linguistic-minority students. The multi-sensory nature of CAIV may thus increase the chances that the appropriate schemata that contain the students' prior knowledge of language and concepts will be activated and the new material will enter long-term memory. The interaction with the computer, and especially with peers at the computer, may help in the construction of a realistic setting in which language occurs naturally as a result of the focus on meaning and problem solving.

Technology and Teacher Education

The use of CAI typically entails changes in classroom interaction patterns between teachers and students and among the students themselves. Teachers no longer find themselves bound to the traditional lecture style of delivering information and can explore a more collaborative style of teaching. Thus, "teachers can go beyond the traditional information delivery mode where they are presenters of ready-made knowledge and become facilitators of students' learning" (OTA, 1988, p. 91). Students, for their part, can become more actively involved in learning, especially when working cooperatively in small groups. Although CAI has long been considered the ideal medium for individualized instruction, researchers (Bork, 1985; Chen, 1985) are now looking at the additional advantages that come from the collaboration and interaction of students who are actively engaged in solving problems at the computer.

However, many teachers are still uncomfortable with the technology needed to create these new and exciting instructional environments for students. Recent surveys (Martinez & Mead, 1988) indicate that most teachers, school computer coordinators included, have little formal training with computers and rate their ability to use computers as little better than mediocre. It is not surprising, then, that computers are still generally used in computing classes, but seldom in subject areas such as reading, social studies, and science. Although most colleges of education require preservice teachers to take at least one course in computer literacy, which typically acquaints students with applications such as word processing, data bases, and spread sheets, preservice teachers seldom observe their professors using technology other than an overhead projector in their classes. As such, while encouraging preservice teachers to integrate new technology into their classrooms, we seldom model what we preach.

However, many colleges of education today are beginning to develop technology-based programs to help preservice teachers adjust to the rapidly changing technology in our society. Theorists argue that technology presented in teacher education programs should focus not only on the learning of technology, but also on the learning of how to use the technology to facilitate their students' learning. Harrington (1991) suggests that technology should be integrated into teacher education programs so as to achieve three objectives:

- to prepare our students to use technology
- to provide them with experiences that incorporate technology in such as way that the substantive goals of our programs are supported, and
- to enable them to develop a critical perspective on the use of technology. (p. 51)

Computer-assisted interactive video programs developed at the University of Houston were designed to meet two of the three above-mentioned goals.

Project Description

The goals of the development project were two-fold: a) to design and implement state of the art curricular materials that would provide authentic learning environments for linguistic-minority students in an elementary school setting, and b) to respond to the state-mandated decreases in elementary content methods courses by preparing computer enhanced curricular materials on current teaching methods in content-based ESL instruction, and to integrate these curricular materials into the teacher education program. The CAIV lessons developed were an attempt to meet the above-mentioned goals.[1]

As summarized in Walker de Felix et al. (1991), the initial year of the grant was dedicated to the purchasing of necessary equipment, training both project and university personnel, and developing prototypic computer-assisted interactive video lessons. Although these prototypes were designed initially on Apple IIGS computers, a decision, based on feedback from both computer consultants and our external evaluator, was made to complete the programs using Macintosh computers. Language and content-area consultants were employed by the grant to assist personnel in the effective integration of technology and content-area materials for linguistic-minority students. Dr. John Bransford of the Cognition and Technology Group at Vanderbilt served as our external evaluator for all three years of the project. During the first year, demonstration prototypes were produced and tested on fourth-grade children limited in English proficiency in the summer of 1989.

The second year of the project was dedicated to the elaboration and completion of five prototypic computer-assisted interactive video lessons in the following content areas: mathematics, social studies, language arts, reading, and science. The CAIV programs used in this study were created by the Title VII Bilingual Training Development and Improvement Project at the University of Houston. Commercially available videodiscs were used, and all programs or "stacks" were developed using a Macintosh SE/30 computer and *HyperCard* (version 1.2.5). These tutorials addressed five content areas: Social Studies (*Plains Indians*), Language Arts (*Charlotte's Web*), Science (*Discovering Dinosaurs*), Mathematics (*Metrics*), and Reading (*Demeter and Persephone*).

In the construction of these tutorials, developers were particularly concerned with the needs of linguistic-minority children in the following three areas: the enhancement of target language proficiency, the development of concepts and strategies important to content areas, and the encouragement of a positive learning environment that would lower the anxieties learners often have toward technology and content-area materials. Once again, lessons were tested on fourth-grade limited English proficient students in the summer of 1990, and feedback from these field trials was used to make final revisions in the programs.

Project personnel were involved mainly in the evaluation, review, and dissemination of findings during the third and final year of the grant. In the fall of 1990, the programs were field tested in two local elementary schools with fourth and fifth graders. The programs were also tested more extensively with fifth grade Latino students during the spring of 1991. At that time, project personnel spent six weeks in a local elementary school in order to evaluate the various features of the programs and their effectiveness in the instruction of linguistic-minority students. The purpose of this study was to measure the effectiveness of three of the five CAIV modules in the transmission of content-area concepts and vocabulary to linguistic-minority students.

The study was conducted in an elementary school in a large urban school district in the Southwestern United States. As indicated in the district's annual profile, the total enrollment for the academic year 1990-1991 was approximately 200,000 students, 86% of whom were designated minorities. Approximately 38,000 of these students were considered limited English proficient (LEP), and 93% of these students spoke Spanish as their native tongue. The elementary school in which the study was conducted had an enrollment of approximately 1,000 students, 99% of whom were Latino. All students who took part in the study were of Hispanic heritage. As a socioeconomic indicator, 86% of the students in this school received free lunch, while 6% received subsidized lunch. Approximately 56% of the total school population was designated as LEP. Sixty-eight out of a total of 162 fifth graders took part in this study. Students ranged in age from ten to thirteen years, with only one of the subjects being 13 years of age. Twenty-nine of the participants were male, while the remaining 39 were female. Only ten of 62 students reported having access to a computer at home.

This study employed a quasi-experimental two-group repeated pretest-posttest design and ran for a period of six weeks. Students worked in groups of two or three for two 30-minute sessions within a six-day period. Prior to their exposure to the three CAIV programs, students were given an initial attitudinal measure. Pretests were administered prior to the introduction of each computer program and immediately following its completion. All posttests were identical to pretest measures, as was the final attitudinal survey, administered at the end of the treatment period. Students also completed a second attitudinal instrument that related specifically to their attitudes toward the programs used.

It was hypothesized that all students would benefit from the CAIV instructional lessons and would score significantly higher on posttest measures than they did on the corresponding pretests. Descriptive statistics for each of the pre- and posttest measures appear below in Table 1. Three separate one-tailed *t* tests for correlated samples were performed. There were significant differences ($p < .016$) found between pretest and posttest scores on all three measures.

Based on previous studies that indicated that children find CAIV instruction enjoyable, it was also hypothesized that participants in this study would report favorable attitudes toward the lessons they had completed on a post-treatment attitude questionnaire. Although this measure contained 43 True/ False items, only twenty that dealt specifically with the students' reactions to the CAIV programs were analyzed for the purpose of this study (alpha = .52). These items can generally be subdivided into four areas, respondent attitudes toward (a) lesson enjoyment, facility, and content, (b) computers, (c) group work, and (d) self and others. The students were also given an opportunity at the end of the questionnaire to write any additional comments about the lessons.

Most students stated they had found the lessons exciting and enjoyable, while approximately 71% claimed that they had not found the lessons boring. Approximately 90% of the participants indicated that the computer was easy to use and that the computer made learning easy. Ninety-five percent of the students reported they were comfortable using the computer. Although approximately 90% of the respondents acknowledged they had enjoyed working in small groups, a small majority admitted they would rather have worked alone on the lessons. Of 52 students who responded in writing, most indicated they had found the lessons interesting and that they had learned a good deal. Some mentioned particular programs or aspects of the lessons they had enjoyed, such as using the mouse. As such, it was evident that most students did in fact find the CAIV tutorials both enjoyable and educational.

The programs were also presented to preservice teachers during the fall of 1990. Forty-two preservice teachers viewed the *Plains' Indians* computer-assisted interactive video lesson in small groups, and questionnaires indicated the program had contributed to their knowledge of the needs of linguistic-minority students

Table 1
One-tailed Correlated *t* Tests for Pre- and Post Achievement Measures

	Pretest		Posttest		
Measure	M	SD	M	SD	*t*
Plains' Indians	13.627	4.159	16.881	4.077	9.708*
Charlotte's Web	19.687	4.432	20.91	4.029	3.670*
Dinosaurs	13.788	4.522	15.833	4.669	4.889*

* $p < .016$

and effective teaching strategies that might be used with this special population. In the open-ended responses, preservice teachers remarked that they had enjoyed the integration of images, sounds, and graphics and the versatility of the computer programs.

With regard to the CAIV technology, teacher education students generally liked the interactive nature of the modules and commented on the motivating or fun aspects of CAIV. Regarding the nature of the curriculum, the majority commented on the beauty of the artwork and noticed the effectiveness of the integrated curriculum. When asked what needed to be improved in the lessons, the students noticed design flaws and technical problems, such as unclear pictures, which were subsequently altered. Most students indicated that they would be willing to use this type of technology, or some modification thereof, in their own classrooms.

Using this initial feedback, the "teacher stack" was subsequently developed and piloted in the spring of 1991. This tutorial was developed for preservice teachers to acquaint them with the difficulties faced by linguistic-minority students in U.S. schools and the benefits of using computer-assisted interactive video instruction to meet the needs of this special population. The teacher stack was constructed in *HyperCard* 1.2.5 and presented students with advantages of interactive video instruction for limited English proficient students. Students branched from the initial menu to sections that dealt with language development, affective considerations, and concept and strategy development. Computer screens presented students with textual information as well as the option to branch to the content-area programs (e.g., *Plains Indians* or *Charlotte's Web*) or visuals from a videodisc that included images of linguistic-minority students interacting with the programs in whole-class or small-group settings. This videodisc was compiled from footage shot when field testing the programs in an inner-city elementary school.

Conclusion

This project has demonstrated one way teacher educators can respond to changing populations and certification requirements. The modules produced and refined over the three years of the project are now available for teacher education students in their computer and content methods classes. As with all technological development, however, the costs of the project should be taken into consideration. Because neither the hardware nor the software were available to the developers before the project, it was crucial that this project be funded by Title VII funds from the federal government. Without external funding, the cost of equipment, personnel, and materials could be prohibitive in this time of higher education cutbacks in the U.S.

The results at the student level as well as at the teacher level indicate that, in this case, the benefits outweighed the costs. Too often, teacher educators use materials in their classes that have not been field tested on school populations. Student teachers who use these modules know that they have already proven successful among LEP students and that they contributed to the children's learning.

Several questions remain, however. Future studies need to investigate the extent to which teachers exposed to the use of technology in their methods courses actually incorporate technology into their content area teaching. Will they use the elements of higher level thinking, strategy instruction, and integrated content areas modeled in the modules, even if they do not have access to CAIV equipment in their schools? Most importantly, how can technology be used in various educational settings to provide the kinds of authentic tasks related to the ordinary practices of the culture (Brown, Duguid & Collins, 1990)? Without the answers to these questions, colleges of education will continue to graduate teachers who have neither the ability nor the inclination to use technology in innovative ways so as to meet the needs of increasingly more diverse populations more effectively.

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[1] These programs were developed with Title VII funds provided by the U.S. Department of Education. Copies of the programs and documentation can be obtained by contacting the authors.

Teaching With Groups: An Interactive Multimedia Program for Teacher Education

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Abstract

Teaching With Groups! is an interactive multimedia primer on group process skills for pre-service and in-service teachers. This two screen program was developed using *HyperCard* and is targeted for national distribution. The conceptual basis for the program includes using contextual modeling of classroom situations, multiple perspectives on examples, and teacher verbalization of their thoughts during activities. The program was designed to bridge the gap between the classroom and the computer lab. Functions for encouraging the integration of this program with existing pre-service teaching curricula include a note-taking and printing facility built into the system.

In a pilot evaluation of *Teaching With Groups!* with 32 preservice teachers, it was found that the program contributed significantly to student confidence in facilitating group activities as well as to students' intention to use group activities in their classrooms.

Learning facts and recalling information has been the focus of public school education from the beginning. However, as the shelf life of information decreases rapidly and the rate of change increases, education has begun to focus more and more on the skills students need to function in an information rich, fast changing, society. Teaching those skills often calls for the teacher to serve as a facilitator of group learning activities. In fact, the ability to learn and work in a group is itself a critical skill students must acquire today. Yet, despite the evident need for educating teachers in techniques for instilling group learning skills in their students, teacher education programs continue to focus primarily on the presentation of information.

With the continuing shift in teacher roles, tools are needed to introduce teachers to group process skills and practices that help facilitate group work in the classroom. *Teaching With Groups!* is an interactive multimedia primer on group process skills for pre-service and in-service teachers. The program written in *HyperCard 2.0*, combines one hour of video examples and narrated overviews with one hour of audio-only information into a highly interactive learning environment.

The current design of *Teaching With Groups!* is a reflection of several months of conceptualizing and prototyping the program. The design team grappled with issues related to how instructional and learning theory interacted with production concerns throughout the design process. Additionally, because the program was targeted for wide distribution, concessions had to be made to the practical demands of the marketplace in terms of a delivery platform. This paper addresses the theoretical orientation of the design team—how it informed our emergent design and affected program content and technical features. The results of a pilot evaluation with pre-service teachers is discussed in the last section.

Theoretical orientation

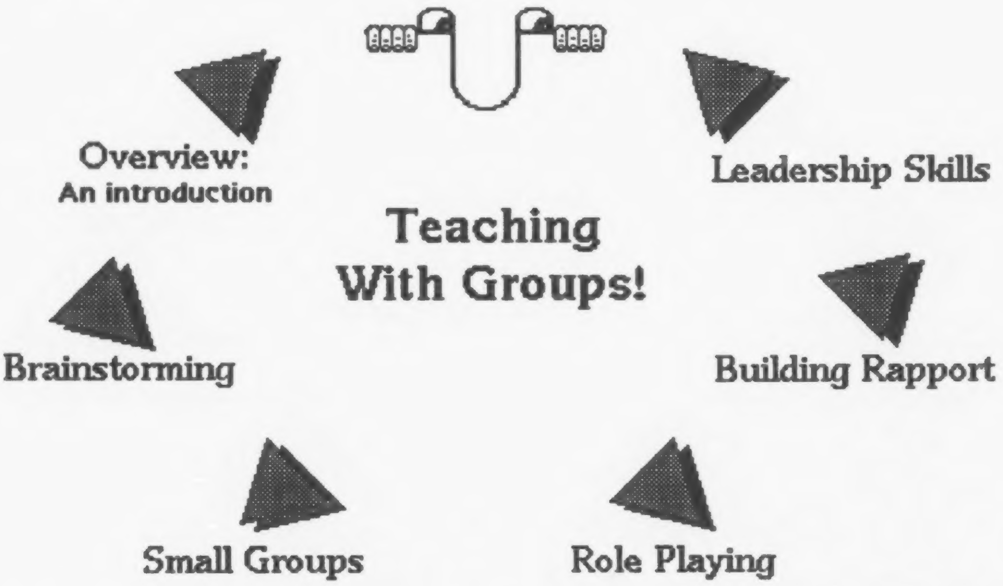
In reaching a consensus as to which theories would best inform our design for the program, the design team asked the following questions: How do humans acquire and master complicated interpersonal skills? Which learning and instructional theories provide us with useful guidelines for enhancing such interpersonal skill acquisition and mastery? In reviewing various learning theories such as cognitive and social learning theories, the design team arrived at three important factors related to social interpersonal skills. First, people perceive phenomena through culturally coded symbols (Bruner, 1990). Second, people master skills through practice in authentic situations (e.g. Brown, Collins, and Duguid, 1989; Dreyfus & Dreyfus, 1985). Third, people reflect upon their thinking and actions through complex and dynamic social interactions (e.g. Bandura, 1972, 1977).

Our first observation prompted the following question: What symbols are most culturally meaningful in transmitting the description of effective group process skills to preservice teachers? Actually modelling teachers' behaviors emerged as the most relevant choice. The use of human models is justified by the notion of culturally coded symbols. The information being taught (mainly procedural rules and interpersonal skills) could have been expressed in a number of ways. We decided that the use of model classroom scenarios complete with teacher, students, and instructional context was the most culturally relevant approach since this is the context in which pre-service teachers would be applying the skills and rules taught. Thus, contextual scenarios constitute the hub around which rule and skill learning takes place.

Regarding the second observation, that people master skills through practice in authentic situations, we called on Dreyfus and Dreyfus' (1985) Five-Stage Model of Skill Acquisition. According to the authors, certain knowledge should not be decomposed into smaller elements. The only way to master these skills in these knowledge domains is to practice in authentic situations that retain the complexity of real life situations. Brown, Collins & Duguid (1989) further advocate that learning should be embedded in authentic activities.

Our third observation, that people reflect upon their thinking and actions through complex and dynamic social interactions, also played a crucial role in our design. According to Bandura (1977), individuals abstract information from the behaviors of others, make decisions about which behaviors to adopt, and later, enact the

Figure 1
Main Menu Design for "Teaching With Groups!"



selected behaviors. We decided to not only demonstrate the model teachers' actions but also allow the student teachers to reflect upon those actions. These reflections constitute the modeling of cognitive activity in which the teacher is engaged.

Program Design

These theories provided guidelines throughout the process of conceptualization and design for *Teaching With Groups!* We now turn to the program attributes that reflect this orientation.

Teaching With Groups! is an open-exploration learning environment that uses text and graphics displayed on a computer monitor as well as video from a laser disc. The main menu design (Figure 1) represents the structure of the program and also reflects its open-exploration orientation. The primary content domains are organized in an open circle representing the metaphor of a small group sitting in a circle. Each content domain is independent of the others.

Within each domain, the user has the option to see an overview, view examples of group activities, learn the logistics of leading a specific activity and, through the use of a challenge or self test, exercise knowledge gained. The menu bar at the top of each screen (see figure 2) represents the set of navigational and learning tools that the learner can call upon during the program session.

Skills and procedures for leading groups are embedded in specific contexts. Users can view two different instructors leading each type of group activity. In addition to seeing these teachers model the facilitation of specific activities, the has the option of viewing each teacher's own reflections on his or her performance, as well as the interpretations of an expert. This allows the learner to consider various perspectives in a largely interpretive area of skill development.

Content

The content of *Teaching With Groups!* is divided into five major sections. Four of these sections focus on specific group strategies; brainstorming, role playing, small group work (cooperative learning), and rapport-building activities. The fifth section focuses on the skills needed to lead and facilitate learning groups. The following describes each of the sections:

- **Brainstorming:** In many classes, student input is often unbalanced due to both competition and a hesitancy among some students to speak up. The structured brainstorming approach discused in this section provides a way for each student's ideas to be considered. In this section, two math teachers use structured brainstorming activities to generate creative solutions to practical mathematics problems.

- **Role Playing:** Role playing is a complex process in which a student assumes the role of a specific character and solves problems as if the student were the character. This strategy is useful in teaching complex communication skills or the understanding of multiple perspectives. In this section a health science teacher uses role playing to teach drug and alcohol resistance skills. In the second example, a social studies teacher uses role playing to facilitate student understanding of the dynamics of a city's growth and development.

- **Small Group Activities:** For cooperative learning and other small group strategies to be successful, the teacher must carefully organize the experience. This section shows how both a homeroom teacher and a social studies teacher introduce students to small group activities, monitor their students' group work, and debrief the activity.

- **Rapport Building:** Developing trust and goodwill among students is an important part of group work. Activities and games can be used to build and maintain a positive climate and healthy relationships among students. This section offers two examples of rapport building. In the first example, a science teacher builds rapport through the use of an icebreaker on the first day of class. In the second, a teacher uses an activity to energize students.

- **Leadership Skills:** The following interpersonal skills are included in the Leadership Skills section.

1. Attending: This represents the ability of the teacher to use his power of observation to monitor the progress of the activity.

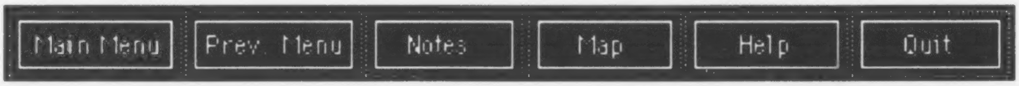


Figure 2. Menu Bar for "Teaching With Groups!"

2. Initiating: This skill involves starting class discussion after an activity in a way that facilitates student participation.

3. Maintaining: This skill focuses on supporting the group process in such a way that the needs of the learners are addressed while the activity progresses toward the instructional goal.

4. Summarizing: Summarizing involves drawing out the main points of a discussion in such a way that the group activity is made relevant to the participants.

Technical Design

The platform for *Teaching With Groups!* incorporates a video monitor with a separate computer screen. The reason for this *two screen* configuration is so that the program may be run on any Macintosh computer produced today. This will allow for the widest possible distribution to educational institutions. The designers have addressed issues related to integrating the information on both screens into a *seamless* environment. That is, neither the computer software nor the videodisc-based information is the primary source of presentation; instead, they function in unison. For instance, graphics presented on the computer screen are combined with audio on the videodisc. In addition, video images are matched with computer-based graphics images to help *tie together* the information on both screens.

Learners are able to navigate through the program according to their own needs and not according to designer-ordained sequences. However, because of its open-exploration design, care had to be taken so that users would not get lost or frustrated in working with the program. Toward this end, several navigational tools are embedded in the program. These include:

- **Main Menu:** The main menu is a hub around which all of the content sections are clustered (see Figure 1). This serves as the primary reference point for the entire program and is always accessible through the top menu bar.

- **Map:** Because this is an open-exploration program, the use of a map is critical. The map is a flowchart that shows users their position in the program at any given time. Additionally, the flowchart also indicates which sections the user has visited and which have not yet been seen.

- **Video Toggle:** This function gives the learner the ability to scan forward or backward in a video segment, view it again, pause the video for note-taking etc. In this way, the learners derive the most benefit from the use of random access videodisc.

- **Interface design concerns:** The visual design of the interface itself reflects the design team's concern for both program consistency and the functional characteristics of all screen selections. A bank of options is available on the menu bar at all times (see Figure 2). In addition, any function that reflects a navigational concern such as searching for video, accessing an elaboration on material, or moving from on screen to another, is designed in white lettering on black. Screen information that relates to instructional *content* is designed in black lettering on a white background.

- **Note-taking/annotating:** When any computer-based program is being used as part of a larger curriculum, those using the program have an agenda that may or may not represent the designers' notion of how the program would be used. *Teaching With Groups!* includes several functions that allow the instructor or workshop leader to tailor the program to personal needs. These include a note-taking and printing facility built into the system that allows students to print out their personal notes, responses to test questions, and summaries of major sections. In addition, there is an electronic folder function that allows a teacher to pose focus questions for a specific group of students. Thus, while the program is designed to be open exploration, it is easy for an instructor to adapt the program so that students can be focused in their tasks.

In addition to the above functions, the program was designed to bridge the gap between the classroom and the computer lab. The *Groups! Presenter* screen allows the teacher to access all of the major video segments from a single menu. This makes the program readily adaptable for use with large groups such as classes and inservice workshops. The following section summarizes an evaluation conducted in what the designers deemed would be the primary user environment, where from one to three students use the program outside of the classroom to augment their in-class experiences.

Evaluation

As a preliminary test of the usability and impact of this multimedia program, pre-service teachers enrolled in one general methods course at a midwestern university were offered the opportunity to use the disc for a 90 minute session. Students received extra credit for participating in this project. Students selected a convenient time for viewing the tape and then naturally grouped with others who could use the materials at the same time. Thus, groups of up to three participated in this evaluation. Of the 34 students in the class, 31 choose to participate. Five were solo users and the rest (26) used it in groups of two (n=14) or three (n=12). The students were representative of that university's preservice teacher population. They were predominantly white, mostly female, and either juniors or seniors.

Students were given a pre-test in class on the day that they were introduced to the multimedia project. The pretest focused on their comfort and experience with using computers and video in educational settings and their experience and willingness to use group process in their teaching. After using the program, each student completed a post-test that focused on two outcome measures: 1) The students' commitment to using the strategies presented in the program, and 2) An increase in the strength of the students' sense that they were prepared to be effective group facilitators.

Discussion

The data indicate that the open-exploration format of the program allows users to adapt the program to fit their own background and learning styles. Additionally, the format used for the Examples sections, where three approaches to viewing the same micro-teaching video sequence are offered, seemed to help the students' ability to identify and understand the various skills the teachers used. Some students indicated that the *2nd Opinion* interpretation of the teaching session brought forward important elements they had missed in simply viewing the example. Others noted that listening to the teacher reflect on the example was beneficial.

This highlights the benefits of allowing learners to navigate the same body of information from many different perspectives, especially in complex content domains such as using procedural rules and interpersonal skills in dynamic classroom environments. Additionally, after using the brainstorming and small group sections of the program, there was a significant increase in students' intentions to use these strategies. Likewise student feelings of being adequately prepared also were positively affected by their exposure to the program. Although these findings are preliminary, they are an indication of the potential of *Teaching With Groups!*. Further study is needed to assess the long-term impact of the program.

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Reflecting Through Technology: A Computer-Laserdisc Model of Cooperative Learning

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Abstract

This paper presents the *HyperCard*/videodisc program IC MODELS, featuring the social model of Cooperative Learning. The *HyperCard*-based program acts as a tutorial about the theory and practice of Cooperative Learning while the videodisc features classroom scenes of Cooperative Learning in action as well as interviews with students and teachers who use Cooperative Learning.

The videodisc brings the power of audiovisual observation to the interactive quality of computers. The result provides personalized feedback as well as the impact of images and sound, which breaks through barriers of time and place in active, reflective, and interactive ways.

Preliminary research results indicate significant cognitive growth ($p<.001$) for preservice education students using the program as well as a more favorable attitude for those students using a content-focused handout with the program.

Technology and Teaching Methods

Renewal in teaching requires a careful examination of what is taught to whom. Consequently, educators at all levels currently struggle with the dual pressures of new concepts and the social dynamic of a new type of audience requiring educational change to maximize learning. Before meaningful content changes can be made, however, the examination of teaching must also focus on the change in context of how a concept is taught.

The Final Report of the Study Group on Conditions of Excellence in American Higher Education (1984) addresses the changing educational environment by outlining the need for ways to directly involve students in their own education. As a primary recommendation, this report asserts that post-secondary faculty need to make greater use of active modes of teaching and require that college students take greater responsibility for their learning and thinking. Students must not only actively learn, they must also reflect upon their learning so they know how and why they learned.

Reflection involves analyzing activities, decisions, and knowledge by reviewing the process one uses to do and to know. Donald Schon (*The Reflective Practitioner*, 1973; and *Educating the Reflective Practitioner*, 1987) outlines two types of reflection: *reflection-on-action*, which focuses on an action and one's thoughts after the action has been completed, and *reflection-in-action*, which requires focusing on one's thinking and action during the activity.

Killion and Todnem (1991) build on these concepts to describe a third type of reflection: *reflection-for-action*. "reflection-for-action is the desired outcome of both previous types of reflection. We undertake reflection, not so much to revisit the past or to become aware of the metacognitive process one is experiencing, but to guide future action. Reflection, then, is a process that encompasses all time designations, past, present, and future simultaneously" (p. 15).

The challenge that any education system faces, therefore, is threefold: to give students active experiences, to give them the guidance and time to reflect about and analyze what they have seen, and to provide significantly different environments so that their experiences and thinking might inform future actions and changes.

This state of the art challenge can be met through the use of technology as an alternative way of breaking through barriers of time and place in active, reflective, and interactive ways.

Active, reflective, and interactive learning processes can now exist simultaneously through the technology of interactive computer-videodisc programs. Furthermore, the change that this technology supports can be multidimensional when the program/laserdisc offers instruction in one model of classroom instruction even as it models technology as another means of instruction. In his book, *Technology and the Transformation of Schools*, Lewis J. Perelman reports that "merely injecting electronic tools into classrooms while leaving the basic design of education systems unaltered offers little hope for major improvements...Technological change and social change are interdependent and inseparable" (Perelman, 1987, p. ES5). It seems natural, then, to use technological means to introduce education students in groups to a social learning environment—cooperative learning.

IC MODELS Program Design

This paper presents the program, IC MODELS (Interactive Computer-Based Models of Instruction), which offers a social model of instruction—cooperative learning—through the technological means of a videodisc linked to an interactive program written in *HyperCard*. The program acts as a tutorial about the theory and syntax of cooperative learning while the videodisc features classroom scenes of cooperative learning in action, as well as interviews with students and teachers who use cooperative learning.

The unique value of a videodisc brings the power of audiovisual observation to the interactive quality of computers. The result is a powerful medium capable of providing two-way, personalized communication with the impact of images and sound.

Advances in video systems have made classroom scenes accessible with such quality that they are the closest thing to being in the classroom. Videos also offer the chance to see a classroom scene again and again, and to focus on different people at different times—an important advantage for studying and reflecting upon a social model that a live classroom visit can't offer. However, in order to utilize the video in this way, a user must find the *right spot* and be aware of what he or she is looking for. When a video segment is transferred onto a laserdisc, all the advantages of good video footage also transfer, but the disadvantages of searching for the right spot, starting at exactly the right spot, and stretching the tape by repeated usage are not transferred.

In addition to quality resolution and convenience, several features of a videodisc make it an effective tool for delivering content:

- Interactive capability allows the videodisc to be controlled by a computer or simply played for review.
- Key information (words, numbers, still and motion images) can be retrieved from any sector on the disc in a second or two.
- Videodiscs are cost-effective when used as a training or educational tool, allowing *follow up* or complete retraining at a student's convenience. The videodisc's ability to present live scenes also reduces the need for field trips and the attending problems of scheduling, transportation, etc.
- There are no time limits on learning, only the time requirements and limitations of the individual running the machine.
- When coupled with a computer program, videodisc is a powerful step up from the videotape, giving the user power to interact. Students can adjust lessons to their own pace, give answers to questions, and retrace steps if need be. They may also recheck scenes between students and students and teacher, focusing individually on each participant.

In planning the video footage for IC MODELS, we chose to use unscripted *real* teachers and students undertaking a lesson for the first time in their own classrooms to provide a reality check about the syntax and implementation of cooperative learning. We also felt that using unscripted lessons provided a credible look at classrooms in action. Slick videotapes that show only brilliant students and teachers can be more intimidating than instructive. This does not mean the lessons to be taped were chosen randomly. Pre-planning with the teachers assured that the cooperative learning concept we were highlighting would be addressed. For example, the lesson which illustrates a jigsaw strategy (computer applications—spreadsheet) was carefully structured so that all parts of the jigsaw would occur in a single day.

Secondary, middle school, and elementary classrooms are featured on the videodisc with math, social studies, and computer applications the target areas of the lessons. The film was originally shot on 3/4" tape with two television cameras for crossover shots, then transferred to 1" tape before being transferred to a videodisc. Setup time for the filming took one to two hours at each school, while the actual class taping was done in one class period. The interviews were also shot in the classrooms immediately after the class to minimize production crew time and school interruptions.

The Cooperative Learning software tutorial, authored in *HyperCard 2.0*, supports new directions in the context of educational best practice by utilizing the following strategies:

- Higher Order Thinking Skills. Students running this program use analysis and evaluation as well as subsuming the lower-level thinking skills in learning through interactive quizzes on the material and the decisions needed to actually use and learn from the program.
- Inside-Outside Focus. Students can project themselves inside classrooms with the visual and oral media, but can also stand outside the classroom to analyze the scene.
- Reflective Teaching Skills. Students receive immediate feedback on their interactive responses and still have as much time as they wish to review and reflect upon the model in action even as they formulate their own plans for the future.
- Individualized Learning. The non-linear nature of the tutorial program allows students to have a wide variety of experiences. The students can begin the project at the best point for them to start.
- Technology Usage. Students profit by learning to use the

computer-videodisc technology. These students will be comfortable with this kind of software as more of it becomes available.

- The teachers featured can be used in a case study format or as models of many effective teaching practices, such as positive reinforcement and verbal or nonverbal communication.

Format of the Instructional Package

The main menu of the program (see Figure 1 below) describes its sequence:

In the first menu topic, the definitions of experts such as Johnson & Johnson, Slavin, and Kagan are provided in the text and glossary entries. Students and teacher who appear in the film add to and interpret these definitions. Similarly, each of the other menu topics have videodisc visuals to clarify the concepts as they are being taught. For example, after the computer tutorial presents the cooperative strategy of "positive interdependence" (a shared focus or goal that enhances learning through consensus and shared problem solving), the computer offers four ways educators can encourage this cooperative strategy. These four techniques are illustrated by video segments in which a teacher models the strategy. Students may elect to "click on" any of the corresponding segments as many times as they wish.

Sections 1 to 7 have subsidiary menus of their own, starting with objectives and ending with an interactive quiz which provides immediate feedback on learning for the user. Additionally, in order to model reflective thinking, students "Visit with Teachers" within Unit 6 so that the teachers in the video might answer some common questions about cooperative issues with which they (and many other teachers) have struggled.

This reflective methodology is revisited in Unit 7—Outcomes of Cooperative Learning—as students and teachers give their reactions to cooperative learning, and teachers outline the problems they have had in implementing the model. It is important for a novice to hear experienced teachers admit that they have found the noise involved in an active-learning model such as cooperative learning bothersome, so that the novice can realize teachers may need to rethink what makes an "ideal" learning environment. The interactive nature of the videodisc makes this possible.

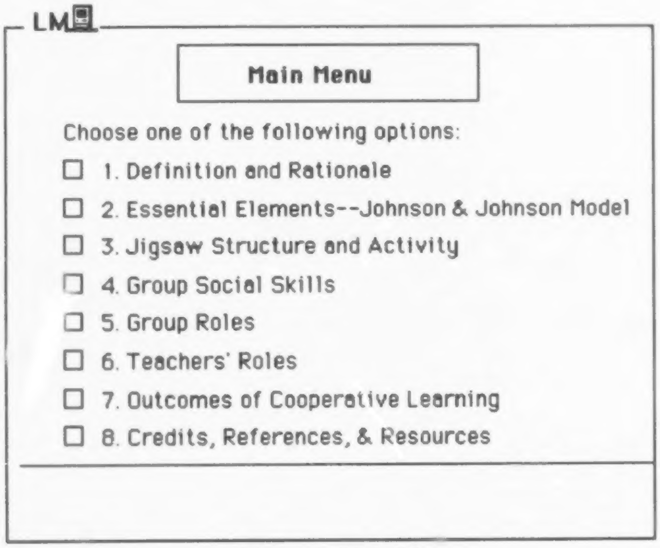
IC MODELS Program

Preliminary research using the IC MODELS program began in Fall, 1991. Students from the Methods of Secondary Education class at Drake University volunteered to learn Cooperative Learning methodology using the IC MODELS program or to be part of a control group using traditional means of introducing Cooperative Learning. The higher number in the IC MODELS group (14) versus the traditional group (7) reflected a general interest in the computer and interest in learning to use interactive *HyperCard*-videodisc technology. Although scores record significant learning from both methods, pre-test and post-test scores indicated a higher mean difference and greater significance for the IC MODELS group.

Table 1. T Test for Dependent Samples

Group	Number	T Ratio	*df*	*p*
Control	7	-4.007	6	<.01
IC MODELS	14	-8.186	13	<.001

Besides tracing the cognitive learning of the experimental and control groups, we sought to clarify the importance of hard copy materials to learning with technology. Accordingly, 6 of the 14



Main Menu

Choose one of the following options:

☐ 1. Definition and Rationale
☐ 2. Essential Elements--Johnson & Johnson Model
☐ 3. Jigsaw Structure and Activity
☐ 4. Group Social Skills
☐ 5. Group Roles
☐ 6. Teachers' Roles
☐ 7. Outcomes of Cooperative Learning
☐ 8. Credits, References, & Resources

Figure 1. Main Menu

Table 2. Attitude Survey of IC MODELS (Likert scale 1=low—5=high)

Program Evaluation	**Computer w/ Handout**	**Computer w/out Handout**
1. Appropriate behavioral objectives.	4.28	3.85
2. Clear Objectives	4.28	4.00
3. Quiz items reflect objectives	4.33	4.14
4. Purpose was clear	4.42	4.28
5. Clear Directions	4.42	4.42
6. Examples of concepts provided	4.42	4.00
7. Content is accurate	4.28	3.57
8. Content is interesting	4.42	4.00
9. Appropriate Feedback	4.00	3.71
10. Promotes active learning	4.28	3.71
11. Menus are clear and easy to use	4.85	4.42
12. Effective use of graphics	4.42	3.85
13. Effective use of sound	4.42	4.14
14. Video is effective	4.28	3.85
Attitude Survey	**Computer w/ Handout**	**Computer w/out Handout**
1. Goals & Objectives of Cooperative Learning can be taught effectively	4.00	4.00
2. Program provides help in retention	3.85	3.14
3. Program has educational value	4.57	4.42
4. Difficulty level is appropriate	4.14	4.42
5. Program does not require special computer training	4.28	4.42
6. Computer valuable in delivering instruction	4.42	4.42
7. Willing to change instructional methods to accommodate computers	4.71	4.14
8. Willing to become more effective with computers	4.71	4.28
9. Computer/laser disc will benefit teacher training	4.42	4.42
10.Computer/laser disc is cost-effective	3.85	3.42
	(N=7)	(N=7)

experimental students received the same handouts as the traditional group, while 8 of the experimental students did not. In a program evaluation/attitude survey on a five-point Likert scale completed by all experimental students after they had worked through the program in small groups (two to three members in each), we found that the students who had worked with handouts had higher attitude ratings on 19 of 24 items. Particularly interesting is a large difference in "willingness to change instructional methods to accommodate computers"—4.71 (handouts) vs. 4.14 (no handouts), and "willing to become more effective with computers"—4.71 (handouts) vs. 4.28 (no handouts). While these are preliminary data with small numbers, the results regarding the usefulness seems to indicate that students feel more comfortable with some textual material about the content of the program available (see Table 2).

When we compared the pre-test/post-test scores for the IC

MODELS group on the basis of handouts versus no handouts, there was no clear advantage for the group having handouts; in fact, the mean growth is slightly lower (7.33 vs. 8.62), but the growth is more stable than the large swings of the group without handouts (see tables 3 and 4 below). Moreover, the group without handouts spent more time on the program as they felt compelled to stop and write things down.

The groups participating in this part of the research effort were preservice secondary education students in the semester immediately before their student teaching. Although obviously profitable at this time for these students, the IC MODELS program could be used by teachers at any level desiring instruction in Cooperative Learning methods.

Table 3. Experimental Group with Handouts

I.D.#	Pretest	Posttest	Difference
3	22	29	7
4	15	21	6
7	15	24	9
10	18	26	8
19	15	18	3
26	14	25	11
MEAN	16.50	23.83	7.33

Table 4. Experimental Group without Handouts

I.D.#	Pretest	Posttest	Difference
5	15	26	11
8	17	21	4
16	13	27	14
18	25	28	3
21	10	23	13
22	14	25	11
23	22	26	4
25	18	27	9
MEAN	16.75	25.37	8.62

Conclusions

Our reflections about using computer/videodisc technology to introduce Cooperative Learning methodology and increase reflective learning and teaching echo the findings of Dwyer, Ringstaff, and Sandholtz (1991), when they state, "the operating principle is to use the media that best support learning goals across the curriculum" (p. 46). Simply working through a tutorial on Cooperative Learning or listening to a presentation about it is not as effective as having the opportunity to see it in action. Inservice training with cooperative activities can imitate a classroom in action, but cannot replace it or replicate the reality of students at a certain grade level. Interactive computer/videodisc programs, however, can project the user into different environments at the click of a mouse and recreate the experience of a classroom situation to a significant degree.

Moreover, teachers today need the reflective-enabling attitudes introduced first by Dewey and confirmed by Canning (1991) and Killion & Todnem (1991), who report that "reflection can alter our common perspective of education and elevate our work to the status of a profession" (p. 16). By encouraging *reflection-for-action* through multimedia examples and immediate feedback, IC MODELS encourages a "thinking presence" in classroom teachers, empowering them to confidently and competently use state-of-the-art methods.

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The Development of Multimedia in Teacher Education

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Abstract

The College of Education at Cleveland State University is engaged in an ongoing project to alter the delivery of instruction in a preservice teacher education program. One aspect of the project invol aves the creation of a multimedia database that combines research-based teaching strategies with videodisc illustrations of the strategies. Key design and development decisions were instrumental in the eventual implementation of the multimedia database. Connections between development and implementation are highlighted.

Media-based instructional materials can be found in classes from pre-school through adult learning in forms as common as books, as simple as poster paints, and as complex as videotape productions. *Multimedia* is simply a combination of elements such as text, audio, visuals and, more recently, computers. It is the last medium, computers, that fuels much of the recent excitement surrounding multimedia in education. The computer adds a dimension of control over the creation and communication of information with multimedia. Before computers, multimedia was often cumbersome to use in the classroom.

Computer control over media is the key element contributing to the further acceptance of multimedia in education. The second key element is the availability of easily accessible databases of audio, visuals, and text.

These two elements pose a problem for instructional developers. How does one take advantage of the first element, computer control, if the second element, multimedia databases, does not exist? The obvious answer is to create a multimedia database, which is easier said than done. The creation of a multimedia database requires a considerable effort in terms of time, expense, expertise, and materials.

Multimedia Tools

Interest in multimedia is on the rise but it is difficult to predict what the future holds for multimedia developers. One issue is certain: if multimedia standards are in a state of evolution then the tools to create multimedia, by analogy, are in a state of revolution.

Spurred by commercial interests in multimedia, both computer hardware manufacturers and software companies are revolutionizing the tools that assist the novice in the production of multimedia materials. Software authoring tools such as *HyperCard* for the Macintosh and *Linkway* for the IBM PC are making control over multimedia a reality for non-programmers. The costs and complexity of computer interfaces and hardware for video scanners and videodisc players continue to drop.

Teacher Education

How will developments in multimedia affect teacher education? It is very difficult to predict the future but the current activities of three comprehensive multimedia development projects in teacher education provide a hint of the potential of multimedia.

The Division of Instruction of the Maryland State Department of Education is working on an interactive instructional framework for in-service teacher staff development. This framework consists of three basic components: a computer database of information and resources related to research-based instructional strategies, illustrations of teachers using the strategies in classrooms on videodisc, and an electronic link to other educators. During the past year, four school sites were selected for the project and technical assistance was provided to support both operation of the system and integration of the framework into school organizations. This year the Maryland team will begin to evaluate the effectiveness of this effort with in-service teachers (S. Burg, personal communication, 1991).

The Learning and Technology Center at Vanderbilt University is developing multimedia materials for use in instruction by in-service teachers. A series of mathematical problem solving materials, *The Adventures of Jaspar Woodbury* were designed to provide an exploratory videodisc-based problem solving environment. Recognizing that video-based instructional strategies influence teaching methods and classroom organization, the Center is conducting research on the nature of teacher training necessary to implement a videodisc-based curriculum and factors that inhibit the implementation of new technologies. The Vanderbilt materials are unique in the area of multimedia in teacher education in that numerous research studies support their effectiveness (Goldman,1991).

The third project is in the College of Education at Cleveland State University and is funded by an Academic Challenge Grant from the Ohio Board of Regents. It is an ongoing project to change the way instruction is delivered in a pre-service teacher education program. One goal is to take advantage of the instructional potential of technology. At Cleveland State, text materials on research-based teaching strategies are combined with video implementations of the strategies into a multimedia database. As a result of a three year design and development effort, a database with hypertext-hypermedia links has evolved. This database is currently being implemented in the undergraduate core teaching curriculum.

Multimedia Development at Cleveland State

Due to the relative newness of multimedia tools, each of the aforementioned efforts may be incorrectly interpreted as having started from scratch with few, if any, ties to earlier efforts. This is not the case. Each of three projects mentioned set out to produce instructional materials with particular goals in mind. Existing models and prototypes were then adapted to meet local needs.

In the case of the Cleveland State multimedia database, the project team built upon the experiences of the Intermedia Project (Meyrowitz, 1986), Grapevine (Campbell & Hanlon, 1988) and the Jari: Problem Solving Environment (Abate, 1988). Not taking this approach would have meant losing much of what has already been systematically researched and learned. However, even with this foundation, initial design of the multimedia database was slow. The wants and needs of the Cleveland State audience were markedly different from those in the aforementioned examples. To meet the Cleveland State audience's needs, it was necessary to determine who the real users were and learn their apparent strengths and weaknesses.

Most faculty have developed their own instructional materials and teaching styles. As such, they have definite opinions about what is appropriate for instruction. Furthermore, it is difficult to predict the needs or wants of faculty when considering the introduction of an instructional innovation such as multimedia. For many faculty members, multimedia is so new and untried that it is dismissed as a passing fad; to others multimedia is an unknown commodity. Perceptions of its usefulness range from panacea to a waste of time.

What, then, is the instructional developer to do to make certain that a multimedia application meets the needs of its users? Through discussion, observation, prototype development, and revision, the characteristics that encourage or inhibit faculty acceptance of multimedia can be identified.

Design Issues and the Multimedia Audience

The project team at Cleveland State posed several questions prior to initiating the multimedia development effort:

- Who will use the materials?
- What will they want?
- What do they really need?

Although the questions are simple, the answers are essential to successful implementation.

Who will use the materials? Before these questions could be answered it was necessary to determine what the faculty already knew about multimedia. Four courses within the undergraduate teacher education curriculum were targeted for revision. Faculty members teaching in the undergraduate core were notified that assistance would be available to individuals interested in developing technology-based instructional materials. Faculty in the reading methods course indicated the greatest interest in the project.

A meeting was scheduled to determine the reading faculty's background knowledge of multimedia, and what modes of teaching were common in the Reading Methods course. Through informal discussions it was determined that faculty had heard of videodiscs but were not exactly sure what they were or how they were currently used in education. Faculty were also asked about their computer usage. Most responses indicated they had used microcomputers for word processing but had not used computers for instructional purposes. Thus, the reading methods instructors could be characterized as computer novices.

Next, the faculty were asked to provide a description of the students who would eventually become users of the multimedia materials. A composite student had the following characteristics. The student was generally older (late twenties), commuted to school, and worked part-time. Many of the students were married, and some were single parents. A common remark was that these students had little free time compared to students at a residential campus .

It was expected that the faculty had little or no experience with technology. However, the considerable outside demands on student time were not anticipated. The implication for the project team was that material development should focus first on use of technology in the classroom.

What will they want? To determine what the faculty wanted, the project team observed the instructional techniques implemented in the Reading Methods course. The average class size per quarter was 70 students. The course was team taught by four instructors. Two 90-minute sessions a week were reserved for lecture, while a third session was spent in small group work. Additionally, students participated in field experiences at local schools throughout the quarter.

Concurrent with these observations, the project team gathered samples of existing multimedia designs to provide the reading faculty with an overview of what was currently available. Two examples were presented: a videodisc-based classroom simulation described by Copeland (1988), and the Brown University Intermedia Project (Meyrowitz,1986). These examples provided a contrast in what was currently considered representative multimedia. The classroom simulation is a videodisc application with a single instructional goal—to teach behavioral techniques for classroom management. The Intermedia project is a computerized document system that provides a hypermedia database environment. The goal of the Intermedia system is to provide a context-sensitive method for accessing and linking to information. Features and functions of the two models were compared to provide the faculty with ideas for applications.

Choice of a proper starting point in the design process was very important. By only presenting two examples, the project team had inadvertently limited the faculty to two options— a simulation or a database. The examples presented were viewed as models for multimedia design rather than as springboards for ideas. Thus, the initial applications suggested by the faculty mirrored the examples. Two requests were forwarded to the team— one for a simulation, another for a database. In retrospect, it may have been wiser to focus faculty attention on the tasks they wished to perform rather than on sample methods for delivering content.

Each student in the Reading Methods class was required to conduct an informal reading inventory. The instructors suggested that a simulation be developed to provide needed practice. A simulation was developed and implemented for five quarters. After the fifth quarter, the faculty member who had requested the simulation left the College, and the simulation is no longer used.

The second suggestion revolved around faculty interest in literacy learning. It was pointed out to the project team that only a few of the reading methods students had the opportunity to observe a language experience lesson in the field. The instructors indicated that a shared observational experience might improve student understanding of the technique. The instructors also indicated they would like to see their students make the connection between the textbook information, lecture materials presented in class, and actual teaching practice. A database tying course materials to video demonstrations of teaching was suggested. This first lesson in the database proved to be the prototype for subsequent database lessons.

What do they need? Determining what the faculty actually needed was not as easy as finding out what they liked or what they wanted. Their needs had to be tied to how they worked. As previously mentioned, much of the instructional "how" of the reading methods class consisted of expository teaching. Therefore, the two suggested applications had to be designed to work with a large group. Also, it cannot be over-emphasized that the faculty's lack of background and experience with multimedia made it especially difficult for them to suggest alternatives to the models presented by the project team.

Continual testing and revision were employed to observe and measure the utility of the applications. During the early phases of development it became apparent that conducting informal evaluation of prototypes allowed for the incorporation of numerous changes and improvements. Revisions were based on anecdotal information provided by faculty and students. This informal assessment proved to be critical to the development and implementation cycle. The informal nature of assessment allowed the project team to observe the effects of changes while incorporating changes incrementally.

Determining the faculty's needs proved to be a difficult task for non-technological reasons as well. After three years of development, none of the reading methods instructors who met for the original design meeting remained on the faculty. Thus, interests and directions had changed. Fortunately, the new project team was able to adapt and modify features of most of the applications, ensuring their continued use. More importantly, newly-hired faculty entered a teaching environment where multimedia materials were expected to be part of the course. Thus, there was an institutional incentive to take advantage of the materials.

Development Process

Determining the needs of the audience was essential for planning and design, but considerable effort was still required for prototype development and initial implementation. The multimedia database, though modest in design, was ambitious in terms of the research and organization of text materials, programming the computer, and creating the video components. After several false starts (Abate, 1990), a custom database template was created for use on a Macintosh computer using the *SuperCard* programming environment. The database template contained the standard Macintosh interface features based on mouse actions and pull-down menus.

The process of adding a lesson to the database consisted of a series of simple yet time consuming steps. First, lesson ideas were solicited from faculty members. Then, reference materials were researched for model lessons. Next, this background information was organized for inclusion in the text portion of the database. Meanwhile, the project team observed local teachers implementing the proposed teaching methodology. If selected, the teacher then produced a new lesson plan demonstrating the methodology. This lesson plan underwent further revision by the project team, reading faculty, and classroom teachers until a consensus was achieved. The lesson plan was then added to the database.

A videotaping session was arranged next. Typically, a hand-held camera and a stationary camera were used to record the implementation of the lesson. The videotapes were then edited to produce a linear lesson of up to 30 minutes. Included on the videotape were still frames of the classroom layout, materials used in the lesson and work produced by the students. The edited lesson was then transferred to videodisc. The last step was to link the visual material stored on the disc with text material stored on the database. At present, there are eleven such lessons available.

Equipment needed to access the multimedia database includes a Macintosh computer, a videodisc player, and a NTSC-compatible monitor. Additional equipment such as a video projector is required to display text and video to a large group.

After three years of development and implementation, two types of applications have gained faculty acceptance: presentations and hypermedia. Both are components of the multimedia database.

Presentations

Faculty take advantage of the presentation capabilities designed into the database for class lectures in several ways. The simplest presentation is linear. A computerized remote control device in the database allows the instructor to present the lesson just as one would with a VCR. This option has proven invaluable as it offers a faculty member with little or no computer experience a simple and manageable mechanism for getting started with the technology.

A Lesson Snapshot utility is provided in the database for instances when the instructor may not have time to present an entire lesson. The Snapshot consists of eight to twelve video segments lasting from 30 seconds to three minutes. Each segment highlights a particular aspect of a lesson. Like the linear presentation, this use requires minimal computer knowledge.

A Video Presenter is a third presentation option. It allows instructors to create custom presentations from the videodisc. Faculty preview the video segments they wish to present and create a record of the segments in a computer file. Once a presentation is created, it may be used again and again.

The Video Presenter is the most frequently used presentation option. When classroom access to computers is difficult, faculty use a special version of the Video Presenter to transfer custom videodisc presentations to videotape, eliminating the need for the computer and videodisc player set up.

HyperMedia

Faculty draw upon the connections provided between text and video in the database during in-class presentations. Reading methods students use the database for outside class assignments. Each lesson in the database includes the following: an overview of the lesson methodology, how the instructor prepared for the lesson, what prior knowledge was required by the students to effectively participate in the lesson, a complete lesson plan with links connecting the plan to what actually occurred in the classroom, examples of work done by the students during the lesson, and references. In addition to the information listed above, comments by the teacher who implemented the lesson are embedded within the text materials to provide a connection between theory and practice.

Factors Influencing the Use of Multimedia

The project team recognized that design choices would affect the ultimate acceptance of the multimedia materials, and it was imperative that the materials supported the tasks of the faculty. Unfortunately, changes in the composition of the faculty meant that these tasks were subject to change. Fortunately, the database was designed to be open-ended and easily modified. Thus, faculty were able to request modifications to suit their individual needs and preferences. The modification option helped faculty become more involved and more comfortable with the medium. Modifiability also meant that faculty outside the reading methods classes were able to adapt materials to meet their needs.

The first impression of multimedia use in the classroom is a lasting one. The ease with which faculty can begin to use the equipment affects the likelihood of their continued use. For this reason, the project team provided support for classroom usage. This turned out to be a mixed blessing. Few technical problems were encountered, but faculty came to rely on outside assistance. Faculty now receive instructions on equipment use, but the project team still provides classroom support when requested.

Much of the faculty's anxiety over equipment use is easy to understand. Classroom use of the database materials requires transporting a cart containing a computer, videodisc player, LCD device and video projector. However, anxiety is not an issue for students' lab assignments. Students attend an orientation that, combined with the computer literacy many bring to class, provides them with sufficient background to use the equipment. Working in small groups at the learning stations, they lend each other support and confidence.

Several issues influenced the development and implementation of the multimedia database. First, technology is in a state of accelerated change. What was impossible three year ago is commonplace today. The size, complexity, and inconvenience of today's equipment is giving way to technology that is smaller and easier to use.

These trends in technology are welcomed, yet it is important to recognize that non-technological considerations are critical to successful implementation as well. Those who are given the mandate for project development must see themselves as bridge builders between user wants and needs and the possibilities of technology. Enhanced personal and institutional incentives can give users the assurance that their continued participation in projects such as the Cleveland State University project is not only valuable for the successful development and implementation of educational multimedia but essential for preparing pre-service teachers for meaningful careers.

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Providing a Video Journal For Preservice Teacher Reflective Development

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Abstract

Videotaping captures complex, simultaneously occurring teacher behaviors and allows multiple opportunities for later reflective review and evaluation. By coordinating the videotaping of teaching presentations across several courses in the professional sequence, preservice teacher education students can evaluate their progress over an extended period of time. Cumulative videotape journals are particularly helpful for observing applied responses to feedback regarding prior videotape evaluations. Summary guide sheets for immediate professor and peer evaluation and for later individual reflective review are provided. Similar creation of a videotape journal may be used for self-evaluation by inservice teachers and college instructors.

Videotaping captures complex, simultaneously occurring teacher behaviors and allows multiple opportunities for later reflective review and evaluation. By coordinating the videotaping of teaching presentations across several courses in the professional development sequence, preservice teacher education students can evaluate their progress over an extended period of time. The cumulative videotape journals are particularly helpful for observing applied responses to feedback regarding videotape evaluations. This paper will describe the steps leading to the use of the video journal and will propose future applications.

Procedure

On this campus, student microteaching demonstrations were videotaped during the last courses before beginning student teaching. Students expressed concern prior to their first videotaping and exhibited some nervousness regarding the activity. In an effort to eliminate this nervousness, frequent videotapings were provided. However, the time required for individuals to give a demonstration and for individuals to review the demonstration with an instructor seemed too time-consuming for any one course. To overcome this, student microteaching demonstrations are now videotaped as soon as possible in the professional development course sequence.

The initial course syllabus lists a blank VHS videotape as a required material and explains the purpose of the videotaping. The instructor as well as class peers provide oral and written feedback. Oral feedback is offered immediately following the presentation in class, while written feedback in note form is provided for the student to take home for later reflection.

Students are to view the tape at least twice, once for their own response and again after reviewing others' feedback. Students are to watch for events that were praised as well as those that were criticized. The exercise is completed by students writing their own comments in response to the activity.

Students retain their videotape as they move to other classes. Any additional opportunities to be videotaped are added to the tape for similar evaluation and review. Students can see if praised behaviors continue to be exhibited and if problem areas improve.

At Texas Lutheran College, this procedure for providing a cumulative video journal is still in its beginning phases as students work their way through the professional sequence of courses. One instructor began the procedure by expanding the use of the videotape from use in one class to use in other classes. Other instructors in the education department have agreed to support the activity as it progresses. This allows students to accumulate a greater sampling of their efforts over time and provides concrete examples of their progress in skill.

Students indicate their initial nervousness has dissipated as the number of videotapings has increased. They also value their individual reflective review of the tapes. Students report seeing events on the tapes that they were not aware of at the time they were taped.

Methods for Feedback

Different methods of feedback have been attempted. At one time, class peers gave only oral feedback immediately following a presentation. Peers were to identify positive examples of effective teaching practices for the presenter. They were also to mention specific areas which might need improvement. The purpose of this feedback was to encourage the student in their video performances by emphasizing the positive but not ignoring the negative.

Although this oral feedback seemed helpful, retention of the feedback was not complete. The additional element of written comments provides a permanent file to accompany the tape. Future students will be requested to retain these written comments with the cumulative videotape record.

As students develop their teaching skills, greater numbers of effective behaviors are exhibited during any single lesson. A written feedback sheet can facilitate the recording of peer and instructor observations. An example of such a summary sheet is provided. A check in the blank would indicate the observation of a particular behavior. The space to the right may be used for comments.

Videotape observation summary sheet

Nonverbal body language

- ___ posture
- ___ eye contact
- ___ eye sweep of room
- ___ effective motions
- ___ distracting motions
- ___ facial expression

Vocal quality

- ___ pleasing quality
- ___ adequate projection
- ___ appropriate vocabulary for students
- ___ appropriate examples for students

Lesson content and procedures

- ___ presented content appropriate for student age and interest
- ___ based content on student academic needs
- ___ referred to prior learning
- ___ gave objective/purpose for lesson
- ___ indicated why content was important to learn
- ___ instructed appropriately
    - modeled
    - defined
    - demonstrated
    - facilitated
    - other
- ___ allowed practice
- ___ used effective questioning strategies
- ___ provided feedback
- ___ evaluated lesson
- ___ provided closure
- ___ provided smooth transition to next activity

Reflective Review

Soon after the class presentation and videotaping session, students watch their own videotaped lesson and prepare a written response for submission to the course instructor. This written response should identify positive, effective teaching practices as well as offer comments about areas needing improvement. As additional videotapings accumulate, students reflect on the current videotape content as well as on any changes in skills occurring over time.

The following summary sheet may be used as an outline to guide the written response.

Reflective review summary sheet

The student will:

- note the beginning and ending time of the videotaped presentation.
- write the purpose of the lesson.
- write the intended grade level and pertinent characteristics of the audience.
- if this is the second or subsequent videotape in the video journal, indicate areas that were especially targeted for improvement.
- watch the videotape and complete a copy of the same evaluation form used by the instructor and peers.
- review the evaluations of the instructor and peers again and tally those responses on another evaluation sheet.
- watch the tape again using the feedback of the instructor and class peers.
- after reflection, prepare additional comments regarding their response and the responses of others to the presentation.

Summary

Microteaching presentations are an important aspect of teacher preparation. Instructors and peers can provide quality feedback after a teaching presentation. If a presentation is videotaped, students can respond to this feedback as well as generate their own responses to their presentation. The activity of reflection is encouraged by having students turn in a timely written response. A future refinement to the video journal is to have students making subsequent tapes identify in advance the particular behaviors they hope to exhibit or avoid during their presentation.

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Usages of Multimedia in Classroom Learning

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Multimedia used as a teaching tool

The purpose of this paper is to present our 1991 experience in using a multimedia program for teaching. We will demonstrate the advantages as well as the difficulties that we have encountered

Multimedia is a technology that is being used today by teachers can be a powerful tool in classroom situations. Ready made programs are available, but teachers can create their own. Successful application of multimedia implies a high cost in planning as well as in purchasing hardware and software. Therefore it is not always easy to start a new project based on this technology. According to Anderson and Veljkov (1990), "it demands teamwork, research, conceptualization, writing, decision making and mastery of technology". We would add that responsibility and discipline are necessary for students to work freely on a given topic. It's important to formulate a plan that makes students eager to use a different methodology and technology. Teachers are certainly not afraid of computers but many teachers do not want to confront using a machine and program with which they are not familiar. Fortunately after presenting our scheme the teachers promptly appreciated the chance to grow into a wider based teaching level.

In this paper we will present some of the problems we faced on using a self designed project, and the solutions we found to get it running smoothly.

Framework

Our project started in September 1990 in a senior class in our school, Escuela Secundaria y Preparatoria de la Ciudad de México, in Mexico City. We were invited by IBM Educational Center in Mexico to participate and experiment with the *Linkway* program, using multimedia. We chose the subject of "Mexico City throughout the centuries" as a framework because it provided a topic that students would be stimulated to work on. As support, IBM donated a PC 60 and the software *Linkway.*

Designing the project

In the senior class, 43 students signed up for the course. This meant organizing them into smaller groups. Half of the students chose to plan and do research work in the school library and other research centers around the city. Some of this group also became involved in taking pictures with the camera. The other half worked on the more technical aspect using the *Linkway* program, a wordprocessor and the scanner.

Never the less, when we started, we only had at our disposal part of the equipment required. While working on the project we succeeded in borrowing and sharing the missing items.

What students learned:

a) students had to choose a subject to work on for a full year.
b) they had to learn to find material on a given subject related to the main framework: Mexico City. The research was taken out of the school are and the information had to be concise and specific. Compositions had to be alive and active, instead of "drill" work.
c) organizing the information found and working on outlines was the next step.
d) write only what is requiredThe *Linkway* program allows you to navigate into different areas, the students design their pages and where these links go. If information is too extensive the final user will not be interested in reading it. The students were reminded of this point.
e) choosing the correct graphs or pictures that would be included on each page, relating theme and written work per page, helped form the balance between pictures and written work.

What multimedia meant for students

The multimedia expanded the students knowledge of the IBM hardware, using printers, scanners, cameras, still video cameras, as well as a variety of software. Added to this was the usage of imagination both for creativity and for handling.

I. Students learn to handle computer program applications.

a) word processor All research was written in the computer and classified into sections that were presented in the *Linkway* outline. Learning the full usage of a word processor and how to change to ASCII, import and export data to the correct page in the *Linkway* folder.
b) data base handling statistics found during research and making graphics; learning to transport them to multimedia program.
c) paint programs We used Psplus and Lw paint to transport scanned pictures and those taken with the still video camera into the program. With the usage of LW capture, students were able to transport their images into the *Linkway* program.
d) animation programs and AVC cards Handling Storyboard live to create active pictures and integrating the videos, together with Sbconvert allows students to change from one program to another and use different modes.

II. Other medias Procured as project necessities demanded:

a) video camera Write a script and a storyboard for the presentation of the video. Handling the camera and timing the presentations.
b) use a still video camera
c) audio equipment for sound effects Learning to choose the correct sound effects that go along with the presentation.
d) scanner

Multimedia for teachers

Relevance

Multimedia activities combine all the teaching aspects a project needs:

a) it is a tool that designs your course according to your needs and class level. In this case, the high school students had to become aware of the pollution in the city and this was done by studying the history of the city. As they did the research work they became involved with their topic, which could be linked to architecture, social studies, history, geography, literature or the subject they were interested in.
b) in fosters creativity and allows students to focus on a means of expressions they enjoy most, whether written, artistic drawing, photography or music.
c) it implies an excellent presentation of the research done.
d) it allows individual work and therefore a variety of forms of expression and presentation that can be brought together under the same framework.
e) it interrelates all the research done by class.
f) mistakes are limited to a minimum and are easily corrected through the *Linkway* program. You might even check it after the project is completed.
g) teachers becomes a motivator and leader who gives suggestions, listens to students ideas and encourages them to do the work and to move on.
h) it is updated and can also easily be kept that way by adding more information any time.
i) it is unlimited in the imagination. Even though you are not able to have all the hardware and software ideally presented, imagination can overcome budget restrictions and the result can be very productive. Once the Mexico City project commenced the teachers became group guides and their attitude towards the students became a friendly relationship in which we experimented and discovered together.

Motivation

The high technology used in class teaching motivates the computer era students to become involved in the work concerned. There are no students who will lag behind because they cannot follow the course, since the class is self designed. The teacher no longer has to cope with discipline problems because the class is bored, since they are allowed to be free in their expression and timing. Not all students want to sit in front of the computer filling in information or designing a page; sometimes they need to look up information or browse around the city for new ideas. This gives the flexibility they want. The teacher must be careful that they don't spend too much time outside the school. However, the motivation was so high the students wanted to finish their project and stayed long after school hours and weekends because they were proud of their work.

Results

The multimedia project proved to be thought provoking, work motivating, and research presentation effective. Students learned to work together as it was one framework divided into the various areas they had chosen, and with which they got involved. Every subject was related since the presentation was throughout the city and in a time line. There is enough research to be done to continue the project for a long time. Talents were discovered and students themselves realized how well they could do any project and find solutions when problems were encountered. Our students matured and found that learning was important for everybody. Experience has shown us that using multimedia can be tried in any other field, and though we are still adding to the Mexico City project, we are also working with a multimedia project in Latin, hoping that students will learn translation techniques and rules through this procedure. Students formed a data-base that will serve anyone interested in learning about Mexico City; it has also helped their peers to find specific data on a given subject such as the Aztec World, where the fourth graders of the elementary school looked up the information in the multimedia program and found facts. Not only did they learn the topic, but they thought that browsing through a computer and switching on the buttons was fantastic. As teachers we would like to add that it was even more rewarding that the information and displays were created by students from an upper grade.

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Interactive Multimedia in the Teaching and Learning of Science

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Abstract

An innovative program of teacher training which incorporates multimedia technology (computers and videodiscs) in the teaching and learning of science is described. The program represents a collaboration of business and education to support the development of effective teaching materials for improving science instruction.

Does the use of interactive multimedia make a difference in the teaching and learning of science? A resounding "yes!" would be the expected response to such a question, based upon the current enthusiasm for the use of interactive multimedia in education. This enthusiasm is supported by research. In fact, several studies (Ambron and Hooper, 1988; Hofmeister, Engelmann, and Carnine, 1989; Romance and Vitale, 1991) suggest that not only is pedagogy enhanced, but also that students' cognitive skills are addressed at several levels.

Interactive Multimedia

Interactive multimedia allows a teacher to become a facilitator of learning. No longer are teachers simply lecturing to a hall full of passive students. Rather they are encouraging students to become actively responsible for their own learning by creating and manipulating information instead of just memorizing facts. Furthermore, multimedia allows for learning experiences to become more visual and non-linear, and abstractions to become concrete experiences. The use of multimedia in instruction often represents one of the purest forms of problem-solving activities available: students must search out information and select what is important (analysis), and present the information in a form understandable to others (synthesis). The program described in this paper represents an attempt to improve pedagogy and to address the development of students' thinking skills through the use of interactive multimedia in the elementary and middle school classroom.

Earth Science/Computer Technology Institute

During the summer of 1991, twenty science teachers from the Aiken County School District in South Carolina were selected to participate in the Earth Science/Computer Technology Institute. Selection was based upon their expertise as science teachers and their enthusiasm for using computer technology in their classrooms. Sponsored by the Ruth Patrick Science Education Center at the University of South Carolina at Aiken and supported by Westinghouse/Savannah River Site, the Department of Energy, and Apple Computer, Inc., the Institute represents a commitment on the part of business and education to address the instructional needs of teachers of science. Westinghouse/Savannah River Site and the Department of Energy provided stipends for the participants which paid for tuition and supplies. Apple Computer, Inc. provided training for the instructor, and videodiscs for all participants. The Institute was offered as two semester-long graduate courses which ran concurrently so that information from one course could be integrated into the other. In the first course, participants conducted intensive study of earth science concepts, examining ways in which these concepts could be introduced to elementary and middle-school students. In the second course, participants designed instructional packages (using *HyperCard*, the Macintosh computer, and laserdisc players) based upon the information and ideas gained from their study in the associated earth science course.

Technology Component

The technology component began with an introduction to the Macintosh computer and the use of *HyperCard*. Participants worked in small groups to prepare instructional stacks for use in their own classrooms. These stacks were then presented to students for field testing. The participants found this to be especially worthwhile for improving stack design: such issues as order of presentation, card appearance, amount of information presented, and general appeal of the stack were addressed as a result of the field testing. Typically, participants discovered that their first stacks included too much narrative information on each card which either confused or bored the user. They also discovered that navigation through the stack should be made as simple as possible. Many of these first stacks served as precursors to stacks which incorporate multimedia images and sound.

Videodiscs and Other Multimedia

Once participants became comfortable with the use of *HyperCard* as an authoring tool, they explored the use of videodiscs and other multimedia devices (CD-ROM, sound input, scanners) which might enhance their stacks. Each student was provided a copy of *The Visual Almanac* videodisc, which is a collection of over 7,000 basic image resources including movies, image sequences, still images and sound. This videodisc is accompanied by software which allows users to access the collections of images, to explore prepared activities utilizing these images and sounds, or to create their own composition. By using standards *HyperCard* conventions users can access the images and sounds available on the videodisc in whatever sequence they desire.

Types of Instructional Stacks

At this point , students began preparing their instructional stacks using the available multimedia resources and incorporating the science concepts they had learned in the accompanying course. These instructional stacks took many forms, typical of the educational uses of multimedia:

1) As a presentation system accompanying a lecture to add clarity and interest. This is perhaps a fundamental use of multimedia, as demonstrated by the Multimedia Electronic Classroom of Purdue University at Indianapolis. A projection device (LCD) allows the display of images from the computer and videodisc.
2) As a one-on-one presentation where a student can respond to questions, make choices and review information. The stack acts as a tutorial and drill-and-practice exercise, a customary purpose of traditional CAI. However, the presentation is enhanced through the use of audio and video images.
3) As a lesson for a small group, which would require discussion among group participants as well as interaction with the technology itself. Such use of multimedia "lends itself to cooperative learning like nothing I have ever experienced" (Watson, 1990-91).

Some of the instructional packages prepared by the participants were appropriate for more than one of the above purposes.

The Future

Those chosen to participate in the Earth Science/ Computer Technology Institute strongly supported the use of interactive multimedia in the classroom, and took back to their classrooms an awareness of both the theory of multimedia use as well as the practical applications for integrating multimedia use with content. The Institute will be replicated during Summer 1992, at which time the problems that occurred in 1991 will be addressed.

The most frequently occurring problems were with the technology itself. It would be beneficial to provide at least one videodisc player for every two participants. Additionally, each computer to be used with a videodisc player should have at least 2 MB of RAM. Furthermore, additional videodiscs (e.g., Tom Snyder Production's *The Great Solar System Rescue* or VideoDiscovery's *Life Cycles*) should be provided. Research topics measuring the effectiveness of such an Institute should address the relative improvement of elementary and middle school students' knowledge of and attitudes toward science after being exposed to the lessons created by the Institute's participants.

Credits

The Earth Science/Computer Technology Institute described in this paper was supported by a grant from the United States Department of Energy, Westinghouse/ Savannah River Corporation. Appreciation is expressed to Jolaine Harbour and Apple Computer, Inc. for providing videodiscs and computers.

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Training Teachers to Organize and Design Computer and Video Projects

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Abstract

This paper is explores some of the general issues involved in training preservice teachers to organize and design projects that make use of advanced technologies—specifically, computer and video projects. Two approaches to organizing such projects are presented, along with general considerations for teaching preservice teachers the necessary technical skills.

Advanced technology has provided educators with a host of tools that enable teachers and students to be more efficient, more creative, and more productive (Van Horn, 1991). Advanced technology has also created a host of challenges for teachers and those in charge of teacher training to master and use these advanced technologies appropriately. The purpose of this paper is to explore some of the general issues involved in training preservice teachers to organize and design projects that make use of advanced technologies—specifically, computer and video projects. Once trained, these teachers can, in turn, teach their students how to use appropriate technologies to organize and use information in the creation of new knowledge.

The Visual Revolution

Young people today are continually bombarded with exciting visual stimuli. A brief look at MTV or Whittle Communication's Channel One, or a visit to a rock concert or sports event attests to the ubiquitous nature of high-tech visual imagery. Fast-paced TV programming with ultra-modern special effects, computer programmed laser light shows that augment live performances, and giant scoreboard/video screens complete with special effects and instant replay are just a few examples of the visual stimuli that bombard the young person of the 1990s. One author states, "There are more hours of pedagogy in one thirty-second commercial than most teachers can pack into a month of teaching" (Drucker, 1989, p. 249). The skill and professionalism that go into producing these high-tech visual images are far beyond the expertise of most teachers today. "Children therefore come to school today with expectations that are bound to be disappointed and frustrated" (Drucker, 1991, p. 249).

It is essential that preservice and inservice teachers become sensitive to the conditions that exist outside of today's schools. Furthermore, they must learn how to manipulate advanced technologies to create a learning environment more in tune with the child's glitzy, visual world in order to curb the frustration and disappointment that students are likely to experience in school.

Step 1: Awareness

My professional teacher education students tell me that once they've planned, produced, and edited a video, they can never look at TV the same way again. They are much more critical of the production values behind the program. Likewise, once students have authored a hypermedia or multimedia program, they say that they can never look at pre-packaged educational courseware the same again. Critical aspects of screen design, pacing, and use of color, sound, and graphics become implanted in their experiential knowledge base. By designing and producing their own media, they become effective evaluators of similar media others have produced.

This phenomenon is something that most classroom teachers say they want their students to experience. In producing original media, a full range of skills are enhanced, from knowledge to evaluation. Additionally, problem solving skills, interpersonal skills, presentation skills, and organizational skills can be reinforced while producing a well-designed video or computer project.

Once preservice teachers are aware of the incredible range of skills that their students can learn by producing video and computer projects, they will be motivated to learn how to organize and design such projects for their students.

Step 2: Organization and Design

In order to get preservice teachers to help their future students produce computer and video projects, it is important to give them a foundation upon which such projects can be organized and designed. The following two approaches are offered for training preservice teachers how to organize computer and video projects for their students. Though there are many other ways to organize these projects, we have found that teachers are likely to have successful experiences if they use these approaches.

First, a project should center around a general topic that lends itself to student-produced media. For example, a middle school earth science class studying volcanoes has much potential for creation of computer and video projects. The class can be carefully divided into groups, and each group assigned a subtopic to research. In our volcano example, one group could be assigned to research the geologic origins of volcanoes; another group could research the mechanical aspects of volcanoes; another group could research the geographical distribution of volcanoes around the world; and still another group could research the impact of volcanoes on society.

Depending upon the type of resources available, a number of different types of projects could be produced. For example, the students or teacher might decide to have the class produce a volcano newsletter using desktop publishing, where each group is responsible for one section of the newsletter. Pictures and graphics could be scanned into the newsletter, and several students could be assigned to be in charge of layout and design of the publication. Each individual group could type their part of the newsletter using a word processing program that can then be imported into a desktop publishing program such as Aldus PageMaker.

A video project could be similarly organized. Students could interview each other providing information about their topic. A copy stand could be used to hold still photographs of volcanic activity while they are being videotaped. If three-dimensional models are available, students could videotape these. The final production might take the format of a news magazine show, like 60 Minutes, with four separate segments. The possibilities are limitless.

One author suggests showing a special screening of the completed video at the school and inviting the public. A video projector can be used to project a large image (Carucio, 1991).

A project does not need to be an elaborate enterprise. Simple newsletters and videos can be valuable and rewarding for students (Carucio, 1991).

Another approach is to have each group choose, with the help of the teacher, the media it would like to use for production. The group researching mechanical aspects of volcanoes might want to develop a *HyperCard* stack showing a cross section of a volcano. Users could click on different parts of the cross section and explore each part in more detail. The group researching geographical distribution of volcanoes around the world might want to create a video using photographs from a variety of books. The group researching the impact of volcanoes on society could create a report using desktop publishing, complete with scanned images and illustrations. The group researching the geologic origins of volcanoes could also produce an instructional video. The end result would be a student produced volcano knowledge base that makes use of a variety of media that students can explore.

There are many other ways to organize and design computer and video projects. The bottom line, however, is making the most of available resources. Having students produce top quality computer and video projects, requires effective teacher training in the uses of educational technology. Many innovative classroom projects require a teacher with a variety of computer and video skills. The following section explores the issues involved in providing preservice teachers the necessary skills.

Step 3: Technical Skills

Once preservice teachers are aware of the value of using computer and video projects and they understand the concepts behind organizing and designing such projects, they may need additional technical expertise in order to be successful. While it is beyond the scope of this paper to explain in detail how to provide teachers with effective training in educational technology, some general suggestions can be offered.

In any situation where new skills are to be taught, the attitude of the learner plays a key role (Dick & Carey, 1990). Perhaps the most important element that preservice courses in educational technology can provide is a positive affect toward technology and its potential in teaching and learning (Bauer & Grzenda, 1991; Zvacek, Bauer, & Grzenda, 1991). This involves providing preservice teachers with technology experiences that are likely to produce success, and sequencing these experiences so that they build upon each other (Munson, Westhof, Bauer, & Smith, 1992). Many excellent instructional design models exist that can aid in the design and development of technology training for preservice teachers. Most of these design models begin with identifying some kind of instructional goal. This goal should be based upon an instructional need determined by a needs assessment or some similar front-end analysis. Objectives can then be written, test items designed, and instructional materials developed, followed by evaluation and revision of the instruction.

One of the ongoing problems in providing technical training for preservice teachers is the wide range of skills and abilities represented in the preservice population. We find that a workshop approach successfully addresses these variations. Students in an educational technology class may choose from a variety of computer and video workshops—some aimed at novices, others at more sophisticated users (Bauer & Grzenda, 1991). Ideally, these workshops should build upon one another.

In the undergraduate educational technology course required of all students at the University of Northern Colorado, we offer workshops in basic word processing, data base, spreadsheet, computer graphics (drawing and painting programs), desktop publishing, courseware selection and evaluation, video production, electronic editing and more. Students also have the opportunity to take a more advanced class entitled Computers in Education in which they explore hypermedia, LOGO, presentation graphics, networking, and other topics.

Once preservice teachers have acquired some rudimentary technological skills, the process of organizing and designing video and computer projects must at least be modeled in their educational technology classes. This modeling would follow the approaches presented in Step 2.

Preservice teachers should also be encouraged to become experts at finding and using information from electronic data bases, such as ERIC and InfoTrack. A wealth of information is available on computer and video projects in the classroom, and such electronic databases make it easy for preservice teachers to research these topics.

The April 1991 issue of *Media & Methods* contains a number of articles on student-produced video, including cookbook approaches to organizing student-produced videos. Computer Studies' *Computers in Education, Fifth Edition* contains 51 articles on various computer topics, from classroom applications to hypermedia and multimedia. Preservice teachers should be encouraged to locate and use such resources.

The Bottom Line

If schools are going to meet the instructional needs of young people of the 1990s and beyond, teachers need to explore new methods of organizing instruction using the tremendously powerful tools that are currently available. By effectively training preservice teachers to use these tools, it is hoped that schools will begin to compete with the child's outside world by making learning more visual and therefore more exciting.

However, this process takes commitment on the part of teacher educators to model and provide high-tech experiences for preservice teachers. It also takes commitment on the part of preservice teachers to develop a willingness to engage in these high-tech teaching and learning experiences. This may involve taking elective courses or continuing education courses that are not part of normal preservice teacher education programs. Preservice teachers could also put subtle pressure on teacher educators who don't model innovation. In fact, preservice teachers could, in fact, model innovation for their professor. Schools, both in higher education and K-12, must commit to supporting the technology needs of new teachers.

If these steps are taken, schools can begin to reflect the explosion of visual information that inundates the world of today's youth, and channel it into valuable learning experiences for both the teacher and the student.

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Issues in Multimedia

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Abstract

This paper has identified several shortcomings of the multimedia technologies when used in instructional applications. These include: poor reliability, time-consuming preparation, operating difficulties and the requisite high capital investment. This study addresses these limitations and proposes the means for improvement. Two research and development projects designed to overcome these deficiencies are described. The Technology Access Governor Project (TAG) and the Multimedia Instructional Portable System (MIPS) Project conducted at the IUPUI integrated Technologies Laboratory are described.

In spite of the nice things we see and hear about multimedia technology, the real story is something else, at least for those with little or no computer experience. Some technologists believed increased capital was the means to fulfilling the technological needs of our schools. They thought once funds were provided, most instructors would switch from the old, dusty chalkboard to the colorful, hi-fi stereo multimedia presentation. Generally speaking, this has not been the case. Some schools spent thousands, if not millions, of dollars to provide technology in the classrooms. After classroom renovations were completed, administrations were surprised to find technology was not being used. Except for a few instructors, the majority continued to use the chalkboard and transparency projector.

No matter how many colors we can include in a multimedia presentation or how many millions of pixels our screen can display, existing technology has major disadvantages over conventional media. The purpose of this paper is to identify and discuss major shortcomings of existing multimedia technology as well as provide possible solutions.

Unreliable Technology

Multimedia technology is not yet reliable. A hardware or software failure during a classroom multimedia presentation is far more likely to occur than problems with a transparency projector or chalkboard. No study has been done to measure the reliability and failure rate of multimedia technologies compared to that traditionally used in the classroom. Our day-to-day observations indicate the reliability of multimedia technology is very low. For example, many presenters at the 1991 Association for Educational Communication and Technology Conference (AECT) in Orlando, Florida, used multimedia technology for their presentations. These presenters also brought transparencies to use as backup if the technology did not work. Unfortunately, it became necessary for some presenters to resort to the old technology.

Timely Preparation

Producing or authoring a multimedia presentation is very time-consuming. More powerful, user-friendly multimedia authoring programs have been developed in the last two years, but there is still a long way to go. Even with a good working knowledge of a computer platform, it still takes days to master a multimedia authoring program. Not only must the authoring software be learned, but also the operation of a still video camera to digitize and save a color picture and other related technologies.

Instructors are very busy people. Most cannot and will not donate their time to learn a new tool. Those who do take the time need equipment, training, assistance, encouragement, and rewards. Sophisticated, expensive multimedia equipment tools in the classroom will continue to be ignored in favor of the chalkboard unless such needs are met. In addition, software companies should pay more attention to human factors and produce programs that are easier to learn and to use.

Complicated Operation

Making a multimedia presentation in the classroom today would likely require assistance from an audio visual or computer technician. Grimes and Potel (1991) define multimedia from a newcomer's perspective, using phrases like "user needs a Ph.D. from Cable University", "like doing film in 1923", "means hardware anxiety" and so forth.

Presentation of multimedia material in the classroom requires appropriate equipment and classroom infrastructure to ensure successful operation. Because hardware and software may have to be configured for each specific multimedia presentation, it is important that the equipment be integrated Even so set-up requirements often result in complicated, time-consuming, operational procedures in the classroom. These include adjustments to the sound system, video projector, or LCD panel, lighting, and so forth. This is technically and ergonomically complicated, as well as confusing and time-consuming, for the instructor in the midst of a lecture. The instructor's role is to teach, not to spend time figuring out which switches to flip or knobs to turn to adjust the presentation.

The operation of technology in the classroom could be simplified by automating the presentation process. Jafari (1990) has identified five requirements that could improve the user - friendliness of technologies in the teaching environment. The teaching environment should include technology systems that meet the following requirements:

- Simple and easy to learn
- Easy to operate technology
- Instant availability
- Greater system reliability
- Features that surpass traditional technologies

Expensive Technology

A multimedia system consists of audio, video, computer, and video projection equipment. The price of these technologies has dropped substantially in the past few years. Nevertheless, prices are still higher than what most schools can afford to spend. Classroom renovation to support multimedia presentations could cost anywhere from $50,000 to one million dollars, depending upon the number of projection screens, computer and video platforms, and infrastructure support needed for a classroom. Providing multimedia technology on a portable cart, similar to the kind used to transport film projectors to classrooms, is the most cost effective and practical method of providing multimedia technology to classrooms.

Needs for Research and Development

Academia has long been a consumer of instructional technologies, but has had few or no resources to do research and development. Technology should be designed using the expertise of both engineers and educators. Now is the time for the educational community to invest in technological research and development. Perelman (1989) in his article, *Schools: America's $500-Billion Flop*, observes that "the technological and organizational innovations that have enabled productivity to soar in other industries will not occur even in a restructured education system without an investment in research and development comparable to other economic sectors."

Indiana University-Purdue University at Indianapolis (IUPUI) may be one of the first educational institutions to invest in and establish a technology research and development laboratory. The Integrated Technologies Laboratory is a research center comprised of engineers, computer experts, educational researchers, and students. The research teams are interested in finding ways to adapt advanced technologies in teaching and learning. The technological shortcomings previously discussed in this paper are areas of greatest concern in this laboratory. In response to these shortcomings, the laboratory has designed, developed, and produced several computer and user interface systems. The TAG (Technology Access Governor) and MIPS (Multimedia Instructional Portable System) projects were developed in the laboratory and will be discussed as they relate to the topic of this paper.

Classroom Technology

There are two distinct methods of providing multimedia technology to support instruction in classrooms. The first is to permanently install multimedia technologies in the classroom; the second is to roll the technology into a conventional classroom, whenever and wherever it is needed. Each method has its own advantages and limitations. These methods are referred to as the *Electronic Classroom* and *Portable Technology* methods, respectively. The first method and its issues are explored in the TAG (Technology Access Governor) project. The second method is embodied in the MIPS (Multimedia Instructional Portable System) project. A combination of the two methods could provide a cost effective, practical solution to multimedia technological needs on campus.

The TAG project

The author started the TAG project in 1987 after Indiana University changed one of its large lecture halls to a "high tech", electronic classroom. Shortly after renovation and installation of the technology, it became apparent that an instructor would need several hours to learn how to operate the technology. One big closet was filled with equipment and each piece of equipment featured several knobs and switches for operation. In order to use the technology, an instructor had to activate a series of switches and make several adjustments to equipment, light systems, and audio boards. In spite of the attraction of large projection display and hi-fi stereo sound, the operation of the equipment was too complex and time-consuming to be accepted by faculty.

The TAG project began as an urgent need to design and develop a computer system that could simplify the use of technology in the classroom. The project was later expanded to improve human-computer interaction, technology reliability, training time, security problems, and data collection (Jafari, 1989).

The TAG hardware consists of a touch-sensitive display panel on the lectern as well as computer and interface boards installed in the equipment rack (Schoenfelt, 1990). For instance, if an instructor wants to play a tape, he or she would touch the word "play" on the touch sensitive display. This generates a series of preprogrammed commands to the interface boards. Such commands include: turning on the video projector, turning on the audio amplifier, routing the VCR signal to video projector and sound system, dimming the house lights, playing the tape, and so forth. These are automatically done in the background and make use of the technology much easier than if performed manually by an instructor.

In 1989, the author continued to test and develop the new TAG2 system, at the newly formed Integrated Technologies Laboratory at Indiana University's Indianapolis campus. TAG2 included all of the original TAG system features as well as more varied control capability for equipment operating on infrared remote control and serial ports on the computer, an improved user interface menu system and the capacity for multimedia multi-screen applications. Before the TAG conceptual design was completed, Elmore (1991), a communications researcher at IUPUI compared the advantages between using sequential displays of several media on one screen with the benefits of simultaneous displays on two or more screens. After a thorough needs analysis and survey of faculty and students, he concluded that simultaneous displays on several media would provide the most effective tools and give presentations the greatest impact.

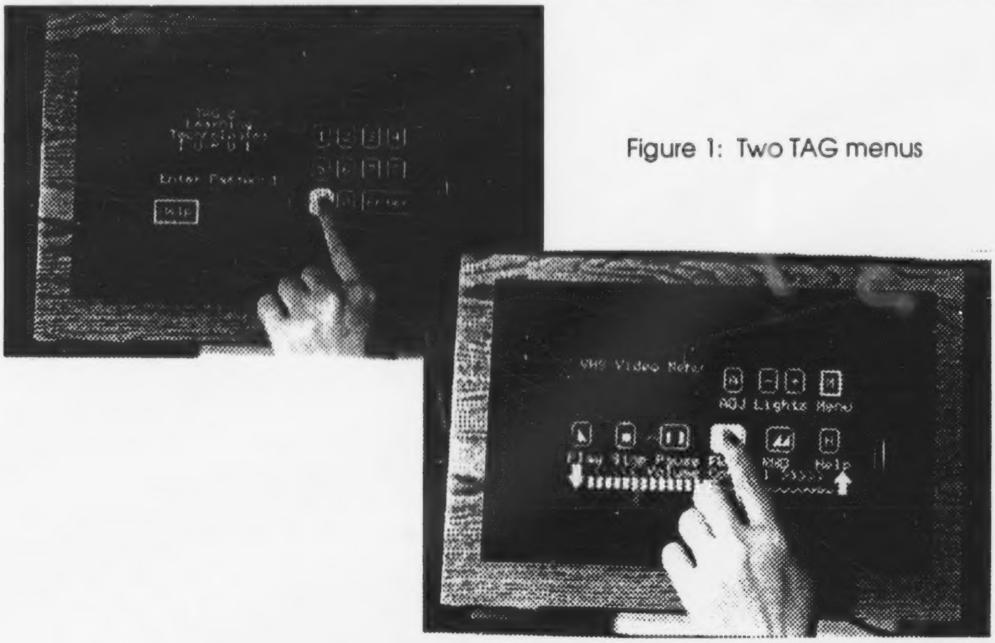

Figure 1: Two TAG menus

His recommendations were implemented in the design of the TAG2 system (Illg, 1990), as well as in the multimedia, electronic classroom at IUPUI known as Lecture Hall 101 (Ravi, 1991). In the summer of 1990, Instructional Computing Services of Carnegie Mellon University joined the Integrated Technologies Laboratory of IUPUI to further test and develop the TAG2 system. A second TAG2 system was installed in a newly-renovated electronic classroom (Bair, 1991).

Human Technology Interaction

The term, "Human-computer interaction" (HCI), is often used to describe the relationship between one operator and one machine (Swift, 1991). In an electronic classroom, the "machine" is a set of equipment integrated in order to provide media presentations. Therefore, a new term, "Human Technology Interaction" HTI should be used. HTI defines the relationship between an operator (instructor) and a series of machines (computers, VCR, videodisc, CD player, satellite down-link, sound mixer, light switches, window shades and the like). HTI is one of the most important factors affecting the success of technologies in the classroom.

One of the main ideas behind the design of the TAG system was to improve and simplify the HTI in the classroom. Besides technology automation, it was intended to provide an interface system that was simple to learn and simple to use. Figure 1 shows two of the menus designed for the TAG2 touch screen system.

In Spring 1991, a study measured and tested the HTI of the TAG2 system. Six groups of individuals in three age groups, male and female, were used for this study. All subjects were invited to Lecture Hall 101 of IUPUI and received five minutes of training on operation of the audio, video, film, and computer systems on the multimedia presentation format. After training was completed, the subjects were asked to perform a series of tasks while the research assistant left the classroom "to take a long distance phone call." These tasks included turning on the computer, placing the computer image on one of the screens, turning on the satellite down-link and placing the picture on another screen, playing a videotape on the VCR, using the document camera for writing and enlargement, showing slides and finally, turning off the entire system and securing it.

This study found that five minutes of training was sufficient for most of the participants to complete their tasks. The younger participants felt more comfortable with technology and finished the tasks faster than the older group. The result of this study will be reported in another publication.

The MIPS Project

The high capital investment needed to provide technology to every classroom is still a major problem. Renovating all of the classrooms of a campus could cost millions of dollars and take many years to complete. Such an investment is not justifiable when a limited number of instructors are occasionally using technologies in their teaching. In addition, campus-wide installation of technology would pose serious maintenance, security, and management concerns.

To address these problems, the development of a portable technical unit was undertaken. Our goal was a unit that could hold a variety of audio, video, and computer equipment and could easily be rolled into any classroom on campus to provide various technology applications for teaching.

Because a portable system was not commercially available, the MIPS project undertook the research and development of a such unit for teaching applications. Figure 2 is a picture of the MIPS unit at the completion of Phase One (Jafari, 1991a).

Several assumptions were made about the applications of MIPS for instruction. These assumptions guided the engineering team at the Integrated Technologies Laboratory in designing and developing the MIPS prototype. The most important assumptions include:

- Multi-Platform: Each instructor is acquainted with a specific hardware platform such as DOS, Macintosh and other computer platforms.
- More Technologies: The market is changing and new technologies are becoming rapidly affordable for classroom use.
- Multimedia: The instructor may simultaneously want to use a combination of different media including audio, text, still images, full motion video and computer images.
- Classroom Independent: Technology may be needed in classrooms of any size.
- Multi-Screen: The instructor may need to use up to three video display devices including video monitors, video projectors and/or LCD panels for simultaneous projection of visual information.
- Minimal Training Time: No more than 15 minutes of an instructor's time will be available for training.
- Fast Set-Up: Only ten minutes or less is required to set up the MIPS unit in the classroom.
- Virtual Resources: The instructor may want to use audio, video and data sources available outside the classroom.
- Interactive Video Conference: Instructors may want to establish a video link between their classroom and another classroom for a teleconferencing application.
- Open Architecture: In rare cases, the instructor may want to interface an external technology or instrument with the system for a specific application or experiment in the classroom.

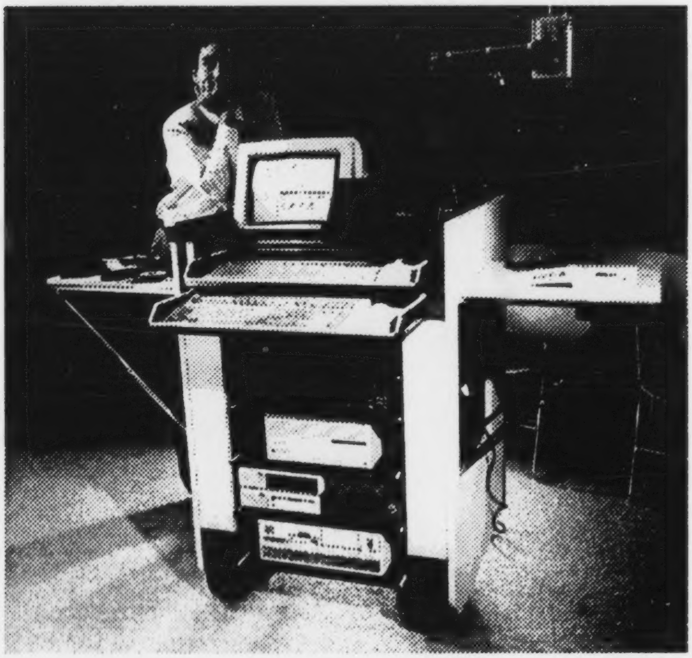

Figure 2: The MIPS system

The Integrated Technologies Laboratory designed and developed a new version of the TAG system to meet the specific requirements of the MIPS project. The main features of the new TAG3 system include automating use of technology in the classroom, providing an easy-to-use HTI, automated switching, and a knowledge-based help system (Jafari, 1991a).

For the MIPS project it was felt that the instructor should be able to get immediate technical assistance in the classroom if he or she experiences hardware/software difficulties. It is not practical to provide technical assistance in every classroom where technology is being used. The best solution is to include a Knowledge Based Help System with the technology. Instructors experiencing a technical difficulty would touch the "help" word on the TAG's touch screen. The TAG will then quickly and automatically locate the best available technician and make a phone call. The TAG decision would be based on factors such as time of call, date, and the type of question or problem.

The Knowledge-Based Help System is a sub-project of the TAG3 system that is expected to solve the majority of problems encountered in classrooms. Emotionally, it will serve to reassure the instructor who will be talking to a "warm body" rather than reading help instructions on a computer screen.

Conclusion

Although we hear many praises for new multimedia technology, it has several shortcomings, especially in classroom applications. We should be aware of these deficiencies and strive to limit them when designing learning environments. Technology administration in schools should charge their design team (architects, media consultants, and engineers) to design electronic learning environments that not only look nice but also ergonomically and technically provide for easy, reliable, and efficient use.

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Barcode/Videodisc Authoring: A New Level of Videodisc Usage

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Hundreds of instructional videodiscs are available in areas such as earth science, art history, and language arts. Educators are often excited about the possibilities of using videodisc materials in conjunction with their own ideas for lessons. Yet a major technical hassle of using videodisc is accessing images using the hand-held remote while lecturing or demonstrating in front of the class.

Publishers who design and produce videodiscs can organize and sequence their content in any manner. By careful insertion of chapter codes and menu screens, the videodisc designer can produce companion lessons that require no more than the PLAY and STEP buttons to present. But for those of us who are attempting to "repurpose" an existing videodisc, presenting lessons of our own design using a remote control is generally quite cumbersome.

The difficulty lies in the control of the videodisc player. A frame number from a lesson can require as many as seven key presses to enter. Additional key presses are needed to control length of play and the selection of audio for full-motion video. Operating the videodisc player in this way while presenting the lesson or leading a discussion is awkward at best.

Computers and authoring software are often used to address this need. Various authoring systems allow the construction of computer-based lessons with embedded playlists that access still images and video sequences at the press of a key or the click of a mouse. However, the time, effort, and resources required for computer-assisted interactive video is often so great as to discourage many educators who would otherwise be interested in developing videodisc-based lessons.

Authoring Tools for Barcoded Lessons

An alternative to using the videodisc remote control is to prepare barcoded lessons. These lessons combine the ease of control of computer-assisted interactive video with the simplicity of printed lessons. In the classroom, a barcode presentation requires only the videodisc player and the video monitor are necessary—no computer is required.

Instead, the videodisc player is controlled by a hand-held barcode reader. Printed barcodes (like those on consumer product labels) contain frame numbers and other information to control the videodisc player. Barcodes are incorporated into the text of a normal lesson plan, lecture notes, or outline to produce a barcoded presentation. The resulting documents can be easily printed and photocopied.

Imagine, if you will, the following scene. A life sciences teacher plans to lecture on cell division. As she lectures, she runs the barcode scanner across the appropriate place in the lesson plan. A full-motion video clip of cell division appears on the monitor at the front of the class. If a student request to see the clip again, she simply runs the barcode reader over the barcode in the lesson plan again—unlike film or videotape, the videodisc player always starts immediately and at the right place. After the class is over, the next teacher needs only to install her own disc in the player and the class is ready to go.

2 0 02300 9 3

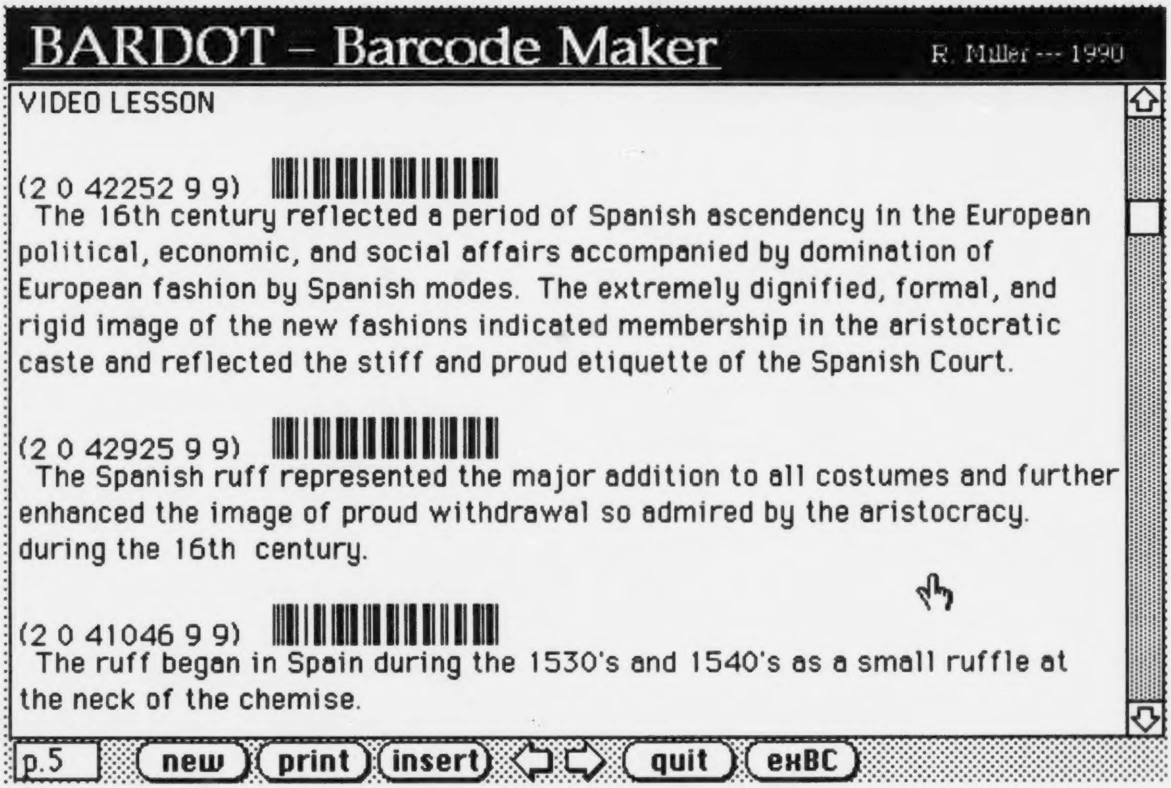
Figure. 1
example of videodisc barcode to access frame 2300

The greatest advantage of barcode lessons is the ease of preparation and presentation. Instead of having to continually key frame numbers into the remote control or worry with creating complicated controls in an authoring system, you simply convert the commands to a barcode format while you prepare your lesson plan, and read them with the barcode scanner while you deliver your lesson.

Any technique for creating barcodes requires special purpose software. The most obvious technique is to use a program that converts videodisc player commands into the appropriate barcodes. With your list of player commands and frame numbers in hand, the commands are keyed into the program. All of the single key player functions such as PLAY and STEP are understood by the software. In addition, access commands such as SEARCH FOR FRAME and PLAY FROM FRAME1 TO FRAME2 are also accepted. For each command, the software produces a barcode that encodes the command and its associated parameters. The barcodes may be stored in a file or sent to a printer.

Lesson or lecture notes can be composed with a word processor or by any other convenient means. The barcodes can then be manually pasted on the printed lesson notes in the appropriate places. Rudimentary barcode tools of this sort are available from several sources, including Pioneer, one of the major manufacturers of videodisc players. Your local Pioneer representative can provide pricing and additional information regarding their barcode software tools.

A more streamlined approach to the authoring of barcoded instructional materials has been developed at the University of Houston. We have developed a Macintosh program, called *BARDOT*, which integrates the creation



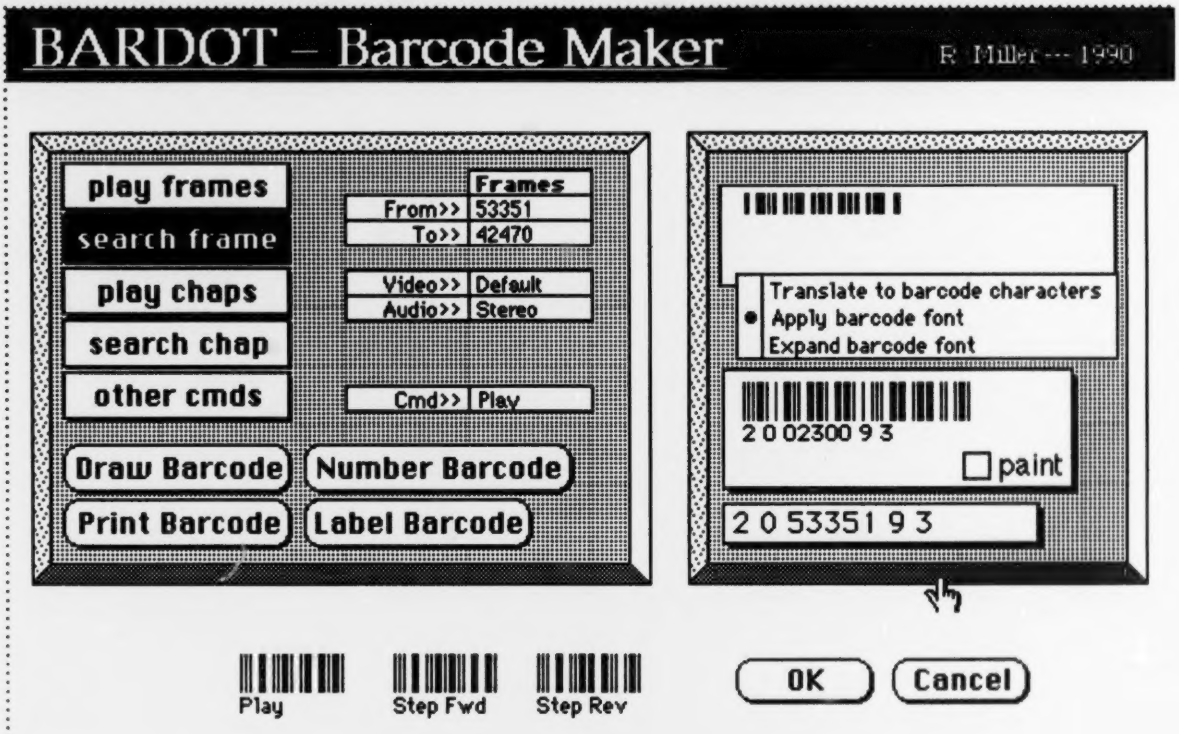
VIDEO LESSON

(2 0 42252 9 9)
The 16th century reflected a period of Spanish ascendency in the European political, economic, and social affairs accompanied by domination of European fashion by Spanish modes. The extremely dignified, formal, and rigid image of the new fashions indicated membership in the aristocratic caste and reflected the stiff and proud etiquette of the Spanish Court.

(2 0 42925 9 9)
The Spanish ruff represented the major addition to all costumes and further enhanced the image of proud withdrawal so admired by the aristocracy. during the 16th century.

(2 0 41046 9 9)
The ruff began in Spain during the 1530's and 1540's as a small ruffle at the neck of the chemise.

Figure 2. example of BARDOT editing window



BARDOT – Barcode Maker

R. Miller --- 1990

Frames

From>> 53351

To>> 42470

Video>> Default

Audio>> Stereo

Cmd>> Play

Translate to barcode characters

● Apply barcode font

Expand barcode font

2 0 02300 9 3

☐ paint

2 0 53351 9 3

Figure 3 — barcode generator screen

of barcodes into the writing process, and functions according to the conventions of the Mac user interface. Additionally, barcodes can be inserted anywhere in a document at the click of the mouse. The program operates in WYSIWYG mode ("What You See Is What You Get" when you print) so that text can be adjusted to accommodate the placement of barcodes.

In *BARDOT*, a *HyperCard 2.0* stack, each card contains one barcode document (Figure 2). Lesson or lecture notes can be composed in a window just as they would in any Macintosh word processor. Barcode commands can be inserted at any point by positioning the cursor in the window and pressing the insert button. A new screen appears (Figure 3) requesting a command, frame numbers, and other appropriate parameters for the barcode. The barcode is constructed by the program. When the author presses OK, it is inserted in the document at the desired location.

Formative Evaluation

In our workshops, pre-service and in-service teachers often express enthusiasm for the videodisc as a teaching resource. Equally common is concern about the difficulty of locating and accessing images on the videodisc using the remote control (level 1 videodisc usage). It has therefore been our hope that the barcode reader would, in large part, solve this access problem.

Several of the faculty and graduate students at the University of Houston involved in the instructional use of the videodisc have converted existing level I and level III (computer-controlled interactive videodisc) modules to barcoded lessons. Initial classroom experiences with these lessons have been positive. The major reason for the positive response appears to be that the presenter's attention can be directed to the classroom (or audience) rather than to a computer screen and remote control. Additionally, the delay of manually calling up frames from the videodisc is largely eliminated so the presentation flows more naturally.

One negative experience noted with new users is difficulty in handling the barcode reader. The device, which is somewhat like a large ball-point pen, must be held in contact with the paper and moved smoothly across the entire extent of the barcode. A certain amount of practice appears necessary to become comfortable with the barcode reader's operation. The practice time required appears to be considerably less than a novice requires to master the use of a mouse.

Conclusion

As more publishers announce plans to produce "electronic textbooks," the role of the videodiscs and videodisc-based lessons seems certain to expand. For the educator interested in repurposing instructional videodiscs, barcoded lessons offer an attractive alternative to the time and expense of computer-controlled interactive video.

While *BARDOT* is still in development, an early version is available for those who contact me on the Internet. The program is available free of charge through electronic mail, provided it is used for non-commercial purposes. The program is also available on diskette for an $8 fee to cover duplication and mailing costs.

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Read-My-Lips: A Multimedia Project for the Hearing Impaired

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Illinois State University

Kathleen Ahlers
Illinois State University

Abstract

Read-My-Lips is an interactive multimedia system designed to help instructors teach language and communication skills to the hearing impaired. Read-My-Lips comprises three multimedia instructional modules: 1) Read & See consists of a series of hypermedia stories and games. The stories are displayed with text and full video motion. New vocabulary within the story is highlighted, so the student may select the words they want to see signed and spoken with the lips using digitized video sequences. The games reinforce the speech-reading of the new vocabulary learned. 2) Babel is an expert system able to translate text-to-speech in any language which uses the Latin alphabet. This module helps instructors teach the fine nuances of phonemes. Each phoneme has a unique sound and thus requires a precise positioning of the vocal organs which are displayed on the screen in two different projections: a front view and a profile cross view of a human face in synchronization with the output sounds of the speech synthesizer. 3) Fingerspelling allows the student to request any word or number to be fingerspelled.

The computer has become a popular instructional tool used in school programs for the hearing impaired (Denninger, 1985). Many computer programs are strictly geared to the presentation and practice of academic content (Braden, Booth, Shaw, Leach, & MacDonald, 1989). However, there are several software packages for the hearing impaired focusing on specific speech, speechreading and/or auditory skills that hearing impaired students have difficulty mastering because of their degree of hearing loss. Hearing impaired individuals demonstrate a wide range of communication deficits including receptive skills, language development, and expressive skills (Fulton, Larson, & Worthy, 1983). Since hearing impaired pupils need to develop both communication skills (speech, speechreading, auditory training) and language skills (word recognition, comprehension of the printed word), software should be designed with both of these areas in mind. However, literature shows that there are no computer packages available that combine these two deficit areas. In this paper, we will look at software designed to reinforce and hopefully improve the communication skill of speechreading, and discuss a program currently being developed to integrate both communication skills and language activities with the hearing impaired population in mind.

Literature Review

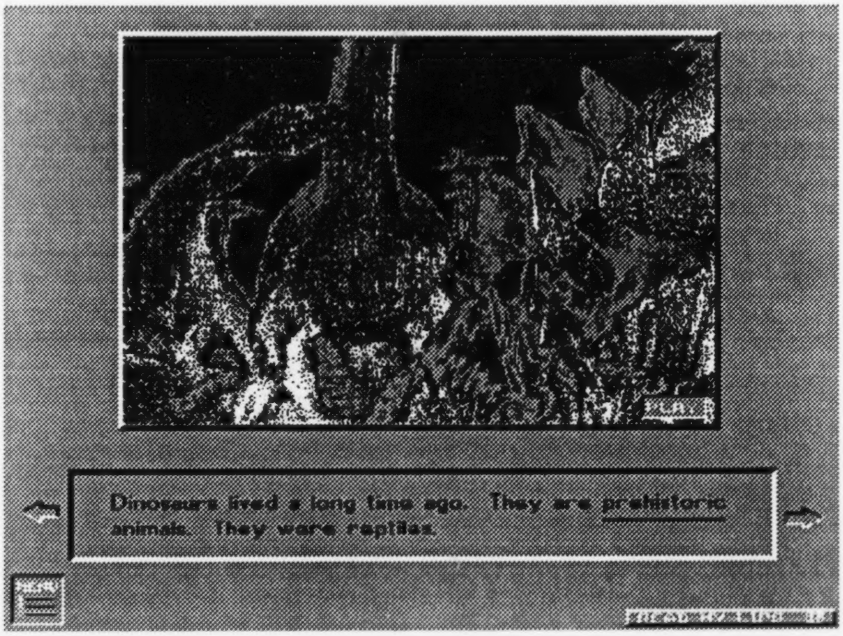
Software specifically for teaching speechreading skills to hearing impaired students mainly consists of drill and practice tutorials. In the early 1970s, low-cost videocassette equipment for educational use began to be used for speechreading. (Sims, 1988) For example, Jacobs (1975) produced self-instruction videotapes for college-aged hearing impaired students at the National Technical Institute for the Deaf in Rochester, New York. The students viewed a prerecorded set of 25 sentences on a given topic and responded to paper and pencil tasks (Sims, 1988). Two other conventional videotape training programs—Read My Lips Course (1987), available from Speechreading Laboratory, Inc., and Lipreading Made Easy (1987), available from Alexander Graham Bell Association for the Deaf—use drill and practice methods for speechreading of everyday utterances. As technology has improved, interactive video capabilities have been used in designing speechreading programs. A system titled *DAVID* (Dynamic Audio Video Interactive Device) was created in 1978. It requires students to view single sentences on videotape and then type what was said into the computer. Students can view a sentence again at anytime by using a "repeat key." "Help" keys are also available, which provide assistance in three ways. On the first request, a clue is given about the subject matter of the particular sentence. On the second request, the computer fills in the first missing or incorrect letter in the student's typed response. If the student requests help three or more times, the computer fills in the first missing or incorrect word. After each of two consecutive help requests, the student is forced to view the sentence again before receiving further assistance (Sims, Scott, and Myers, 1982). Analysis of the data collected on the students' performance indicated improved ability in their speechreading (Sims, Snell, and Clymer, 1984).

Kopra, Abrahamson, and Dunlop (1986) detailed the first use of laser videodisc for speechreading practice. They used a videodisc system to present 300 sentence-length stimuli, where sentences were shown in order of increasing difficulty. Boothroyd (1987), Tyler, Tye-Murray, and Gantz (1987), and Bernstein and Eberhardt (1986) have also used interactive videotape or videodisc to investigate the benefits of cochlear implants and tactile sensory aids to speechreading and to research some of its component skills.

Currently, most of the software packages for speechreading use drill and practice. The student watches someone saying a statement, and responds by either writing down what was said or typing it into the computer. Drill and practice activities have their place in a hearing impaired individual's education, but how can this often difficult task be enlivened, especially for the young deaf child?

Read-My-Lips

Read-My-Lips was designed and developed bearing in mind the educational needs (language and communication



Dinosaurs lived a long time ago. They are prehistoric animals. They were reptiles.

Figure 1: Read & See: Dinosaurs Hypermedia Story

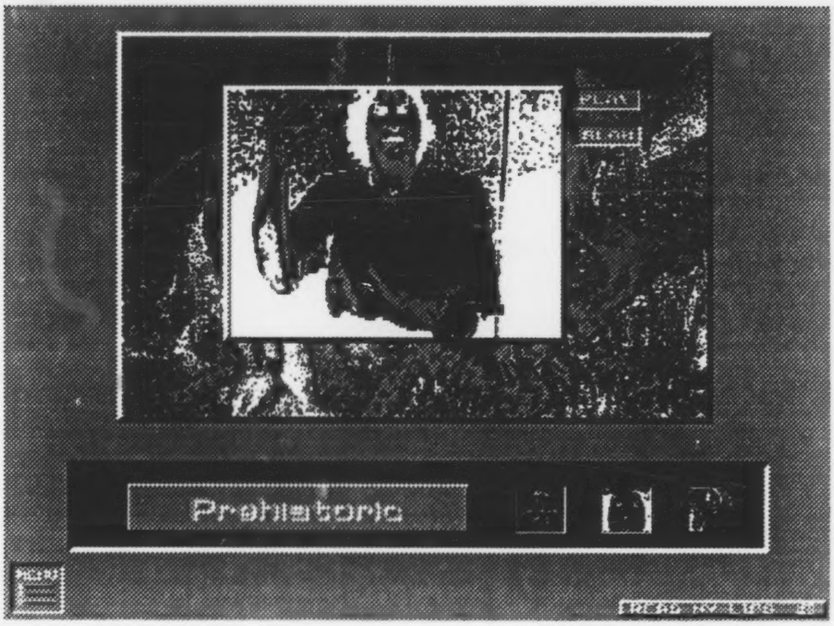


Figure 2: Read & See: Signing the word "Prehistoric"

skills) of young deaf children. Read-My-Lips makes use of state-of-the-art multimedia technology that enables the creation of powerful and entertaining interactive instructional materials.

Read-My-Lips helps instructors to learn and teach the fine nuances of lip-reading through an interactive multimedia approach. The system consists of the following instructional modules: Read & See, Babel, and Fingerspelling.

Read & See

This module consists of a series of hypermedia (fiction or non- fiction) stories to which students have been exposed in the classroom. The stories are told with text and full video motion sequences, during which students can read the passage at their own pace. See Figure 1 and Figure 2.

New vocabulary within the story is highlighted, so the student may use a mouse to choose the words they want to see signed and spoken with the lips. A digitized video is then superimposed on the screen. This way the student can see how the word appears on the lips and also review how the word is signed. After the entire story is read and viewed by the student, different speechreading activities are presented so that the student can use the new vocabulary both in isolation and in the context of sentences.

A student must first understand the language being used in a speechreading exercise in order for the activity to have any meaning. By integrating a language component with speechreading, students can see how particular speechreading activities are relevant and how they allow them to understand other people.

The digitized video sequences of Read & See were created using the Video-Editor facility of *IBM StoryBoard Live!* in VGA resolution. The digitized video sequences were displayed with only twelve shades of grey. Thus, illumination in the video shooting was critical to ensure the display of vocal organs, particularly the tongue, lips, and teeth.

Babel Babel is an expert system able to graphically animate and acoustically reproduce a text in any language which uses the Latin alphabet. This module has been developed to aid learners and to help instructors teach phonemes. Each phoneme has a unique sound and thus requires a precise positioning of the vocal organs which are displayed on the screen in two different projections: a front view and a profile cross view of a human face in synchronization with the output sounds of the speech synthesizer. See Figure 3.

Fingerspelling

This component fingerspells any word or number requested by the student.

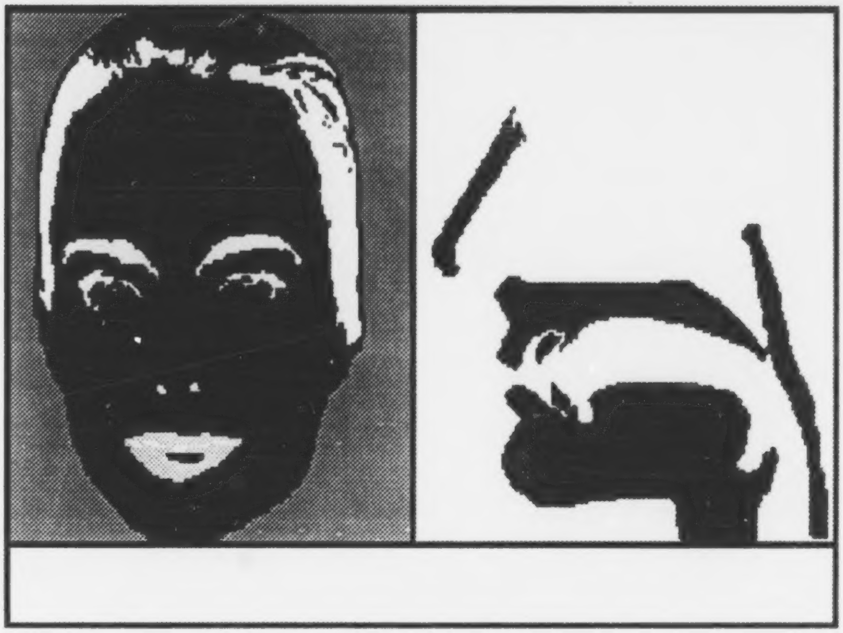


Figure 3: Babel's Projection of the Human Faces

Remarks

Read-My-Lips will be tested with hearing impaired students in the primary and intermediate levels at Metcalf Laboratory School on the campus of Illinois State University .

Acknowledgements

The authors wish to thank Mr. Rafael Gomez, Assistant to the Dean of the College of Education at Illinois State University, for shooting the video sequences and assisting in completing the project.

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Multiple Site Inservice Teacher Education: Via Interactive Television

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Abstract

This paper describes the use of two-way interactive television (ITV) in the program leading to the Master of Education in Teacher Leadership offered at the University of Minnesota, Twin Cities.

The University of Minnesota is providing instruction via interactive television (ITV). Disadvantages associated with the ITV process include difficulty in recognition of students, audio feedback from microphones, classroom noise levels, broken or malfunctioning equipment, and ITV network down time.

Institutional benefits include increased market share, lowered demand for classrooms, and positive relationships with other educational agencies. Students experience fewer problems associated with on campus classes including ease of registration, short commuting distance, and greater accessibility to parking. Instructors,using the ITV team teaching approach broaden their teaching repertoire, making use of available multimedia technology and developing a multi-perspective approach to teaching. For these reasons, ITV is an appropriate, effective, and desirable method of inservice teacher education

The University of Minnesota Twin Cities, through a joint effort by the College of Education and the Continuing Education and Extension Division, established a M.Ed. in Teacher Leadership. The program was developed by two units within the College of Education: the Department of Curriculum and Instruction and the Department of Education Policy and Administration.

The Master of Education in Teacher Leadership program objectives are:

1. to develop advanced skills in specific curricular areas related to current and future teaching assignments
2. to provide an understanding of current reform and policy issues facing education
3. to develop leadership skills that are particularly relevant for classroom teachers who participate in development work in their school.

The ITV Course

The course used as the basis of this paper is "Shared Decision Making and Group Process." This new course was designed to assist educators in becoming effective participants in the decision making process. The course focuses on opportunities for decision making that have developed as a result of educational change, including site-based management and outcome-based education. Topics covered include effective group process, decision making, multi-constituent group behavior, learning styles, and effective leadership.

Because this was the instructors' first attempt at using ITV, as well as the beginning of a new course and a new program, it was decided the course would be team taught by two senior faculty members with the assistance of a graduate student. Each member of the team rotated among the three sites.

The University of Minnesota chose to offer the class using a two-way ITV fiber optic network. The ITV classrooms were located in two high school district buildings and one intermediate school building.

Classroom Equipment

Each classroom had three cameras, one focusing on the instructor, another on the students, and a third on visual materials. The instructor selected the signal to be sent from a switcher located on the control center, which was adjacent to the instructor's desk. Students observed their site as well as the others' from three color monitors located in the front of the class. Teacher remote-site monitors were located in the rear of the class. The instructor monitored the signal being sent from the home site via a nine-inch monochrome monitor on the desk.

A microphone was located on each student's desk. Instructor's microphones attached to a lapel or collar. All microphones were controlled from a sound mixer located at the teaching center and were live at all times unless turned off at the mixer.

Each classroom also had a FAX machine for transmission among the sites. The fax machines contained phones that could be used to communicate between sites. Also located at the control center was a VCR that could broadcast to all sites. However, the VCR could only record the signal being sent from the home site, instead of the signals from all the sites. Computer hook-ups were also available for delivering computer images to the sites.

Discussion

It was no small undertaking to attempt to teach a shared decision making and group process course on ITV. The subject matter demands extensive work in groups and debriefing sessions. Some believe it is ineffective to teach this course using ITV because of a perceived communication limitation among the sites.

One way to overcome these perceived limitations is an initial orientation session for instructors and students to familiarize them with ITV. This orientation is most important for instructors, since they control the equipment. A moderate level of proficiency can be gained in a relatively short training session. Such a training session also decreases the apprehension an instructor feels when using new technology.

When using ITV and team-teaching, thorough preparation is essential. One of the best ways is to write a script. Scripts may take many forms, from a word-for-word copy of what will be said to a general outline of material to be covered. The most essential aspect of a script is time allocation. The ITV process seems to require more time to complete a task than in the traditional classroom. This is especially true in group work and discussion sections, as it takes longer to gain the site's attention after an exercise, as well as to distribute and collect written materials. As a result, it is recommended that a generous block of time be allocated for each task.

Problems

As with any innovation, there were problems. First, it was difficult for instructors to learn the students' names and faces as quickly as they would like to do so. This is especially true for large ITV classrooms or for those students who sit in the back. To combat this problem, large name plates that were clearly readable from 25 feet were constructed. However, facial recognition continued to be a problem. A solution would be to purchase a wide angle, higher magnification camera lens or, if possible, to move the students closer to the camera.

Second, sound feedback was a problem, especially from the remote site's instructor's microphones. This was solved by turning the volume to zero when not in use. A related problem was the noise level during the class. Students forgot that their microphones are voice-activated. Consequently, students' in-class chatter was received by all sites, thus increasing the classroom noise level. A reminder to students from time to time alleviated this problem.

Third, at times the ITV system was down. This can be frustrating to students and instructors, especially in a content-oriented course. We suggest that a technician check each site at least two hours before class to ensure the system is working. This allows enough time to notify students to convene at an alternate site if possible, or to cancel class.

Other technical problems experienced were broken speaker wires, inconsistent volume levels among sites, and malfunctioning monitors and FAX machines. For these reasons, it is helpful to have an on-site technician to handle any minor mechanical problems.

Advantages

In general, the benefits of ITV far outweigh the problems. First, institutions gain a larger share of the education market by providing classes for people who do not wish to attend classes on campus. The possibility exists in the future to reach teachers in isolated areas for whom there are no other educational opportunities available. Second, the demand for on-campus classroom space is decreased. Finally, ITV builds a spirit of cooperation between the university and local high schools.

Students also benefit from courses offered through

ITV. Teachers enrolled in the program can remain in their work building to take classes. For others, sites located close to their homes reduces commuting time, parking difficulties, and long walking distances usually associated with large urban universities. Registration is easier because students can register by mail or on the first night of class. Representatives of the Continuing Education and Extension Division bring textbooks for the students to purchase on the first night of class, eliminating the need to go to a campus bookstore to purchase course materials. Interactive television allows students to network with other teachers at the different sites. Finally, ITV provides students with a model for using technology as part of the teaching process.

Instructors also benefit from the ITV process. First, the team teaching approach requires instructors to meet regularly to plan and discuss class content and process. All instructors are able to incorporate their individual perspectives, providing students several ways to view the subject matter. Second, team teaching exposes more instructors to ITV, which increases the number of individuals with ITV experience to teach classes in the future. Finally, there are methodological and pedagogical challenges inherent in ITV that must be overcome, such as developing ways to use the technology to address a content area that would ordinarily best occur in the traditional classroom.

Conclusion

The University of Minnesota is providing instruction via ITV for courses taken through the Master of Education in Teacher Leadership Program. Disadvantages associated with the ITV process include difficulty in recognizing students, audio feedback from microphones, classroom noise levels, broken or malfunctioning equipment ITV network down-time. However, the benefits far outweigh the problems. Institutional benefits include increased market share, lowered demand for classrooms, and positive relationships with other educational agencies. Students experience fewer problems associated with on-campus classes including ease of registration, short commuting distance, and greater accessibility to parking. Instructors using the ITV team-teaching approach broaden their teaching repertoire by making use of available multimedia technology and developing a multi-perspective approach to teaching. For these reasons, ITV is an appropriate, effective, and desirable method of inservice teacher education.

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Designing and Using a Technology-Intensive Teaching Environment

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Abstract

One of the critical questions facing the educational community during the last decade of this century involves the need to educate students at all levels to compete in an ever more complex, highly integrated and sophisticated socioeconomic system. This concern has been articulated in President Bush's *America 2000*, and in various state policy documents, private sector initiatives, and planning documents of professional associations. At a time when the demands on teachers are spiraling at an alarming rate, the nation also finds itself with fewer economic resources, a neglected educational system, and a teacher education curriculum and process increasingly under attack because of what is viewed as poor student performance.

In response to these and other issues, there have been several major national initiatives to enhance the delivery of education and to improve teacher preparation through the infusion of electronics and communications technologies into the educational system. Many of the programs being explored by the National Science Teacher's Association, such as interactive mastery testing based on the new commercial CD-I technology, programs funded under the Eisenhower (Title II), and NSF education grants are designed to improve the quality of teaching and learning, to better test student mastery of material, and to take advantage of the ability of children to learn visually material that might otherwise be difficult to impart. Similarly, because of the need for cost containment, *distance learning* is also being explored as a means for enriching the curriculum and providing services to special populations that would be too expensive for individual school districts to provide independently. In short, technology is being treated as the tool for solving many of the most pressing problems in education today.

One of the major difficulties with the current emphasis on technology is that there is relatively little systematic attention being paid to testing the actual impact of the programs on learning. In the head-long rush to upgrade programs, there are few efforts being made to systematically test curriculum materials, to evaluate their impact on learning, and to assess the role of technological applications within real school settings. Indeed, even in the recent national Eisenhower competition, little attention was paid to the assessment and evaluation of programs proposed.

Similarly, it is also apparent the current emphasis on technological applications in education cannot ignore the needs of current teachers. Most current practicing teachers graduated from schools and during eras when electronics and communications technologies were not integrated into most teacher education programs. Similarly, many school districts have not had the funds to offer in-service education for teachers. Thus, any potential benefits of newer technologies may be obviated by the inability of teachers to appropriately supervise and apply the techniques.

In an effort to address these issues, Bridgewater State College has begun a developmental process that has culminated in the establishment of the Old Colony Center for Technological Applications.

Development of the Old Colony Center for Technology Applications

The Old Colony Center began as an idea in the fall of 1990. In April, 1991, it began to operate as a series of programs designed to revitalize teacher education through the application of new educational technologies. When completely developed, it will consist of a campus-wide network, a 45,000 square foot academic building and a satellite system linking the College to other institutions nationally and internationally. Full funding has been received for the network, building, educational equipment and satellite system. The Center's pilot programs have already begun and the satellite earth station is slated to be operational by Fall,1992 with the building to be completed by late Fall,1993 and all components of the campus network finished by 1994.

How was Bridgewater able to make such progress toward the development of the Old Colony Center in such a short period of time?

With approximately 6000 undergraduates and several thousand graduate students, Bridgewater State College has a 150-year history of work in the field of teacher education and is one of the three oldest teacher-training institutions in the United States. Yet in recent years, the College had expanded its liberal arts and sciences programs as well as several professional programs to become a comprehensive institution of higher education. As in the case of so many similar institutions, teacher education had become only one of many programs vying for College resources, despite the fact that a strong core of faculty and students remained involved with teacher education. A new focus and vision was lacking.

With the hiring of Dr. Adrian Tinsley as the College's new President in the fall of 1989 and other members of the administration in the summer of 1990, the stage was set for the College to begin a strategic planning process that would help find a new vision for Bridgewater. As a first step, the Office of the Vice President for Academic Affairs undertook an extensive study of all College academic programs during the fall of 1990. The hidden potential of the College's teacher preparation programs (both in-service and pre-service) began to emerge. This study revealed that many science, mathematics, and computer science faculty were involved and interested in teacher education. They had a history of receiving teacher enhancement grants from the National Science Foundation, the U.S. Department of Energy, the U.S. Department of Education, and a number of state funded grant programs. Together with their counterparts in the College's education departments, they formed a strong resource base for the development of programs that would make use of emerging educational technologies.

The actual idea for the Old Colony Center developed from the close collaboration between members of the College's staff and the science coordinator from a local public school system. It is important to note that the process of development stressed an equal partnership between the College and local schools. Thus the Center has been a true school/college collaboration from the beginning. Together they sketched out the broad outlines for the Center which would enable it to:

- develop, implement, and disseminate a national model for collaboration and partnership among the educational and private enterprise sectors to improve the quality of pre K-12 science, math, and technology education,
- develop, implement and distribute national models of science and technology curricula that couple the hands-on learning program being developed by the National Academy of Science/Smithsonian National Science Resource Center with a local teacher ment*or and master teacher* model that makes maximum use of new communications and computing technologies,
- enhance the training of pre-service and in-service teachers in the uses of communications and computing technologies,
- provide a work setting where in-service teachers and College faculty can interact to improve the integration of practice and theory,
- produce new applications of communications and computing technologies to enhance learning across all subject areas, but especially in the sciences and mathematics,
- provide direct service to Massachusetts school districts through interactive distance learning and local *hands on* mentor programs, especially for gifted and talented students,
- create a venue for demonstrations of curricula and educational technology that can be used in local school districts and distributed nationally,
- furnish a facility within which business persons, pre-K through twelfth grade educators, and College faculty can come together to establish programs of mutual interest, to receive training and to work toward solving educational and economic problems.

These concepts were grounded in current research about pre-K through twelfth grade education. The Center's focus on curriculum development emphasizes teachers. Too often, as in the case of the new math of the late sixties and early seventies, teachers were not fully included in the development and adaptation of curricula. One of the major failures of the Elementary Science Study (ESS), Science Curriculum Improvement Study (SCIS) and Science - A Process Approach (SAPA) was the lack of teacher input and support (Shymansky, 1989). Consequently, the Curriculum and Teacher Center, which is part of the Old Colony Center for Technological Applications, is designed to support teachers working alone or in teams with administrators to develop and adapt educational technologies for the classroom. A number of teachers will be named Bridgewater State College Fellows and will remain at the College for one to two semesters at a time to work on a wide range of curriculum development projects.

In addition, the Center combines *hands on* learning with distance learning. A re-analysis during the mid-eighties (Shymansky, 1989) of the data on student performance across all new elementary science curricula showed that students in *hands on* discovery programs scored significantly higher than their peers in traditional elementary science classes. The data revealed that students in the *hands on* programs not only had significantly higher scores in their attitudes toward science and in their process skills, but also in overall achievement and problem solving skills. Other studies (House, 1980; Berlin and Jones, 1987) suggest that curriculum developers should integrate mathematics and reading instruction with science. A possible conclusion from these studies is that science and mathematics curricula can be improved by using an integrated, *hands on*, inquiry-based approach.

Based on theories by W. Edwards Deming (Rhodes, Nov. 1990, Dec. 1990; Tribus, 1990; Yoshida, 1989), Peter Senge (199) and others, we took the approach of enabling school systems to use teams of faculty, administrators, parents and community leaders to jointly develop curricula and enhance teaching and learning.

> *Unless educators are willing to reconceptualize curriculum and instruction (and perhaps the organization and process of schooling itself), they will probably need to be quite patient in expecting transformation to occur through the use of computers and other tools. (Mojkowski, 1990)*

Thus, the Center planners realized early on that educational technology can not be infused into schools without re-examining the curriculum, how it is taught, and the way that schools are structured. Indeed, educational technology can be used as a force for change in schools. (Withrow, 1990) The most dramatic example is in distance learning, which enables students to have access to courses like calculus that might not be offered otherwise. Distance learning also enables teachers and administrators to stay in touch with the latest developments in educational technology via seminars and workshops that can then be implemented locally by on-site mentors who have been trained at the Old Colony Center.

This vision is now being carried out as part of the Center's first major project: an NSF-funded program to enable secondary math and science teachers to work together on curriculum development. During the summer of 1991, the teachers learned about the wide range of technology available from CD-ROM to interactive video systems and how these tools can be used in developing lessons. They then worked with computers and repeated experiments they had first done in labs, but this time using new variables with the computers. They used a mathematics package for computers that worked like a graphic calculator and they began to see how they could develop a wide range of scenarios for teaching merely by changing the parameters set forth at the beginning of each problem.

Additionally, the opportunity to attend educational technology workshops was also offered to all teachers within commuting distance of the College. These workshops were uniformly over-subscribed. Field reports indicate that teachers have begun making use of what they learned at the College, but can hardly wait until the Center's resource library is fully operational so that they can try out new software packages. They are particularly interested in having College faculty test new educational technology first. The College has initiated the beginnings of such a program with its Center for the Application of Research in Teaching (CART). There, a faculty member versed in computers and related educational technology is working with faculty to adapt existing software and courseware to classroom use as well as to begin developing new software. Several publishers have expressed interest in collaborating in these curricular development efforts as work progresses.

All these initiatives would occur without the grant that is funding a new building, network and satellite earthstation. But the infusion of a $10 million dollar grant from the U.S. Department of Energy will enable all components of the Center to become a reality within the next few years. Without the initial vision for the Center, the U.S. Department of Energy grant and the other resources that are now becoming available to the Center through corporate and other sources of support would not have been possible. Thus, the lesson learned from the Old Colony Center for Technological Applications is that no matter how big the dream, you should try to make it a reality.

What are some of the key steps remaining in the Center's evolution?

A team of faculty and administrators are planning the details for the Center complex. At present, it will include:

1) The **Core Building**, which will house teaching and research laboratories and support facilities, two electronic seminar rooms, an electronic lecture hall, a curriculum and teacher center, and a computer center. Other uses for the building include a meteorological laboratory and television capacity in all classrooms and lecture halls. Engineers at Bridgewater State College are working in conjunction with the Environmental Protection Agency and other nationally recognized experts to make the building a national model of environmentally sound construction.
2) The **Burnell Lab School** (elementary/middle school), which will be outfitted with new equipment and will continue as an ongoing test site for direct instruction. One of the oldest lab schools in the country, the Burnell School was recently selected by Boston's WGBH (in conjunction with PBS) as one of 15 demonstration sites nationwide for testing educational technology.
3) The **Campus Telecommunications Network**, which will allow access to the Center's resources by all faculty and partners. Using voice, video and data transmission, the network will feature a fiber optics, wide band dark fiber spine linking the Center to all major campus buildings.
4) The **Earth Station**, which will provide national and interactive links through interactive telecommunications using a variety of voice, video and data links based on satellite and microwave transmission. The Earth Station is slated to be operational by Fall,1992.

Interest in participating in the development of the Center has been expressed by corporations interested in education (as well as educational technology), school systems, state and federal officials, and a wide range of individuals and organizations with expertise in various fields of study, leadership and management theory, curriculum development, and distance learning.

With the available human and financial resources, the Center will be completed. Some questions remain, which we are currently working on:

- How can we adapt the best aspects of the traditional curriculum to the challenges of an information age society?
- How can we link our resources with other curriculum and teacher centers nationally and internationally?
- How can we incorporate the flexibility necessary to accommodate new technologies that will be developed over the next 20-30 years?

Implications for teacher education at Bridgewater State College and elsewhere in the U.S. include the following:

- We need to begin to plan for joint in-service/pre-service teacher training. (The use of distance learning coupled with some joint work on-site in schools or at the Center could accomplish this.)
- Technology must be considered as a means of creating a level playing field for previously disadvantaged school systems. (Distance learning will fill a critical course gap for some students and the lowering costs of CD-I and other technologies can bring them into disadvantaged schools, so teacher training institutions must be prepared to train teachers in these new technologies.)
- True partnerships between K-12 and higher education are critical for the development of effective programs in technological applications. The skills of practitioners in each sector complement the other, and the resource bases are very different. As is demonstrated by the Old Colony Center, collaboration in program design and implementation can produce exciting benefits that have the potential to address many of the most pressing problems facing the country today.

In sum, we expect:

Students, teachers, educators, business leaders and technology experts will visit the Center in person or through two-way video links. Teachers and faculty will access the Curriculum and Teacher Center library on the spot or over distance by computer. Teleconferences on subjects ranging from *Higher Education in Britain and America to Soviet-American Science Education* will be held on a regular basis.

In addition, scientists and educators will be using the Center's electronics laboratories to collaborate on new classroom applications for educational technology. Public school teachers and administrators will no longer be isolated but will be linked to the latest in educational technology and curriculum developments through the Center and its national and international connections.

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PRESERVICE TEACHER EDUCATION

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All of the papers in this section consider some aspect of teacher education in the area of technology. Be it preservice or inservice, graduate or undergraduate, broad focus or narrow focus, programmatic or course specific, theoretical or practical; the substance of each paper contributes to the overall theme of instructing teachers in the uses of computers and related technology to direct, to enhance, or to manage instruction. The papers tend to group into three subcategories: broad programmatic efforts, course-specific efforts, and special related topics.

Programmatic Efforts

Each of the papers in this category describes broadly-based measures taken in schools of education to bootstrap teacher training programs to a higher level of technology. As the keen-eyed reader will note, many of these efforts include sizeable grants from private corporations and other entities. For example, Gartmann describes the implementation of a grant from a large computer manufacturer. Many in education believe that preservice technology training should be integrated into the general undergraduate teacher-training curriculum; Handler tells us of her school's efforts. Munson, Westhoff, Bauer, and Smith relate the efforts at their institution to integrate technology into the undergraduate and the graduate teacher education program. Although many programmatic efforts at innovation work top-down, Stephen and Ryan tell us how a grass-roots movement has succeeded at their college. The President's mandate at Stuckman, Fisher, Schottenstein, and Highby's university, interestingly, resulted in collaboration with many different colleges. Efforts at Uhlig's school, focussed on the development of a new Ph.D. program in Instructional Development, were innovative and equally broad-based.

Course-Specific Efforts

The papers in this category tend to be more narrowly focussed than entire institutional overhaul. Biglan, for example, relates a very interesting approach to preservice teacher training in which laboratory sessions are conducted at the site of and in collaboration with a local K-12 school, while Cashman and McCraw identify the advantages and disadvantages of school-day inservice training. A community college effort is described in Hirsch and Buckley's paper on how, in a language development course, they turned five-year-olds into teacher trainers. Maury's paper describes how the vehicle of problem-solving can be used to drive teachers' introduction to technology. Picciano portrays the task of teaching teachers about technology within the context of a strongly field-based undergraduate program. Westhoff shows us how he integrates software for mathematics into inservice teacher training.

Special Related Topics

Every paper in this category details a topic related to teacher training in technology. Clark and Downs provide us with valuable information about using shareware and public domain software for teacher training. Jennings, Pearson, and Britenriker describe the use of technology to facilitate and to refine the process of evaluating student teaching. Kahn strongly supports the use of Logo in teacher training ... and gives some reasons that you may not have heard before. The results of Stowe's survey of AACTE member institutions on the topics of teacher preparedness for the information age and institutional change may hold some surprises for you as well. Finally, White has something to say about research findings on instructional computing and their inclusion in undergraduate and graduate courses.

Taken collectively, these papers represent extremely diverse and potent efforts to infuse technology into the fabric of teacher training. If you are at all involved or interested in preparing teachers for careers in the information age, it is hard to imagine that you could read this collection of papers on teacher education and not come away with new knowledge or a broader perspective.

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Preservice Instructional Technology: The Old, The New and The Future

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Abstract

In a one semester course, students review relevant learning theory and principles of instructional design, taught by college faculty. The six to seven session laboratory section of the course is taught in a local school by a teacher from that school, with access to current media and materials. The revolution in instructional technology may leave teacher education behind because many schools or departments of education do not have the most current equipment nor a wealth of instructional material appropriate for children in elementary and secondary schools. An instructional technology course should give the preservice teacher the best of both worlds: a solid base of learning theory and instructional design and a first hand experience with technology in the classrooms of today. This program is one step in the preparation of teachers for the classrooms of tomorrow.

Introduction

In the not so distant past, instructional technology consisted of using the overhead, filmstrip, movie projectors, and some audio input from phonograph records and cassette tapes. Undergraduates were schooled in the mechanics, preparation and selection of materials for these machines. Technology now includes videocassette recorders, computers, CD-ROM, telecommunications, and laserdiscs. Multimedia is a growing trend in classroom presentations at all levels of education. In order to adequately prepare students to fulfill their roles as successful classroom teachers, the old as well as the new technologies must be addressed in teacher preparation programs.

These new technologies demand hands-on training for acquiring competency. Unless preservice teachers can use the new technologies to develop instructional strategies in a practice mode where trial and error and retry are part of the learning environment, the necessary skills for teaching in the 21st century will not be acquired. Schools or departments of education need, therefore, to align themselves with schools where technology is part of the daily delivery of instruction. The preservice teachers need time to practice with materials children use every day before they begin their classroom experiences.

Program Description

In this one semester course, students review relevant learning theory and principles of instructional design. This section is taught by college faculty. The six to seven session laboratory section of the course is taught in a local elementary school by a teacher from that school, with access to materials appropriate for all grade levels. Preservice teachers complete units on The Use of Computers as a tool for both teachers and students, The Instructional Use of Videotapes, Interactive Videodisc, Preparation of Instructional Materials, and Multimedia Presentations. The preservice teachers are involved with independent work, cooperative learning, and large group presentations. Their final project is a multimedia presentation suitable for a classroom situation of their choice ranging from kindergarten to twelfth grade.

In the sessions on using computers, students learn to use the computer as a tool for their personal productivity. Word processing includes writing lesson plans, letters to parents and resumes; all important phases of communication for future teachers. By building and manipulating data bases containing student records, classroom inventories and reading or assignment lists the student can appreciated the organizational capabilities of computer use. Spreadsheets are introduced as a tool for student grades, able to instantly average and update records. The second part of the unit on computer use involves exploring the computer as an instructional tool. By using a great variety of computer software, discussions concerning appropriate use of software in a classroom setting are stimulated. The software utilization unit also involves discussion of one computer-one classroom, simulations and cooperative learning, the role of the teacher in computer-assisted instruction, and choosing instructional sound software.

Using videotapes in a classroom can be as mundane as simply showing a tape from beginning to end. However, the instructional benefit of this use is questionable. Students learn how to preview and select appropriate materials. After selecting materials, students learn how to integrate the video into an overall instructional plan. Student video production as a teaching strategy is also explored with small groups producing some unique video moments for the class to share.

Interactive Videodisc is probably the most unfamiliar technology for the preservice teachers. Using a variety of commercially available videodiscs, students explore the unique search and find capabilities of this medium. Short lessons using the videodisc as an aid to a lecture presentation is the first experience in this unit. Depending upon their capability and interest, some students advance to computer interface with the videodisc player. This allows even greater flexibility and teacher creation of learning materials. Students quickly see the future role of videodisc technology in the classroom. The role as creator of instructional materials for the teachers of the twenty first century will be very different from the past.

The unit on the preparation of instructional materials also involves using utility computer software for publishing everything from signs and banners to student books and newspapers. Traditional technologies of overhead, opaque, slide and filmstrip projection are also included in this unit. Working in small groups, students produce a slide show on the computer. From this on-computer presentation, actual slides can be produced and shown in a slide projector. The preservice teachers experience a meeting of the old and the new technologies in this unit.

The multimedia unit requires the students to use all previous experience to plan classroom presentations. The final project is a multimedia presentation suitable for a classroom situation of their choice. At least three different types of media must be used in their unit plan. Because all possible equipment and a great wealth of instructional material is available to them, the students use all their newly acquired knowledge to present technologically sophisticated instructional units.

Conclusion

While newspapers and journals speak of the revolution in instructional technology, teacher education still lags behind because many schools or departments of education do not have the most current equipment nor a wealth of instructional material appropriate for children in elementary and secondary schools. We have addressed this problem by having the Instructional Technology course co-taught by college and local school faculty members. This structure gives the preservice teacher the best of both worlds; a solid base of learning theory and instructional design and a first hand experience with technology in the classrooms of today. This program is one step in the preparation of teachers for the classrooms of tomorrow.

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Providing Inservice Computer Training for Teachers During the School Day

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Abstract

Providing inservice computer training during the regular school day in a rural school, while well received by teachers, is not without problems. Included in this paper is a discussion of the goals and objectives of an inservice computer training program, the success of meeting these goals, the problems encountered, and how they were overcome.

Introduction and Significance

Providing inservice computer training and technical support that is relevant to the classroom teacher is a first step to integrating computers into the classroom curriculum. Without training and support, computer use in the average classroom will continue to be little more than a filler activity. Sturdivant (1989) identified 10 obstacles that were faced by the Houston Independent School District in encouraging teachers to use computers with their students. Of these obstacles, the following were identified as relevant to the school setting in which we implemented computer training: lack of teacher incentives, limited time for staff development, limited opportunities for teachers to observe model applications, teacher isolation with few opportunities for sharing, limited software and computer access, lack of assistance, and lack of feedback and direction. Persky's study (1990) recognizes these obstacles, particularly the need for technical and emotional support as teachers try to integrate the use of computers in their class curriculum.

Glenn and Carrier (1989) state that technology inservice is important because the majority of teachers currently teaching in schools have had very little, if any, technology training. As a consequence, they have not used the computer or any advanced technology in the classroom, and they further find that few teachers will take the initiative to seek additional technology training or education.

Fulton (1988) maintains that the most crucial factors in giving teachers an opportunity to develop competence and confidence in using computers are time and support . Alifrangis (1991) also recognizes time as a factor necessary for teachers to develop competence in using computers in an educational setting. She found that, in spite of their good intentions, "teachers rarely sat down and went through the various programs themselves. Without this background information, they cannot easily integrate the [programs] with those in the classrooms; they cannot anticipate difficulties the students might have and thus, better prepare the students for those particular programs; and they cannot offer productive ongoing assistance" (p. 60). In addition to lack of time, Kimpston (1990/91) identified lack of communication among teachers, computer coordinators, and administrators as a major obstacle to computer use.

Methodology

Data were collected through:

1. Semi-structured and unstructured interviews with the principal and teachers.
2. Direct daily observations of teachers in the computer lab.
3. Baseline questionnaires and interviews with the teachers to capture their philosophies of education, their perceptions of the role of computers in education, their views of how students learn, and the extent of their knowledge of computers.

Data collected from observations and interviews were triangulated to provide a full description of the research environment. Pseudonums were used to maintain, as much as possible, the anonymity of the principal and teachers.

Framing the Case

In August, 1991, two rural schools jointly received a one year Small Schools Cooperative Grant from the state of Oklahoma for the implementation of a computer program. The $35,000 grant was intended to improve students' problem solving and critical thinking skills through the use of computers. The grant money was allocated for the purchase of hardware, software and the employment of a computer coordinator.

The original goals of the grant were written by the Quaint City principal as follows:

1. To teach computer skills to the elementary students at Quaint City and Farther Out.
2. To increase the students' exposure to and experience with computers.
3. To give students practice using critical thinking and logical thinking skill which will be used in learning how computers work (think).

From the goals. the principal derived the following objectives:

1. Students will demonstrate a statistically significant gain in computer skills as measured by a pre and post test.
2. Students will increase the time they spend working with a computer from approximately one quarter hour per week to one and one quarter hours per week.
3. Students will demonstrate statistically significant gains in critical thinking as measured by the following appropriate instrument: (a) Cornell Critical Thinking Test (b) Creative Reasoning Test by John Doolittle (c) Classroom measures of student's ability in computer logic (thinking).

The principal proposed curriculum activities for the grant were :

(a) Keyboarding; (b) basic computer operation (on/off, loading programs, saving data); (c) Information processing; (d) Output (producing work with the computer); (e) Logo programming; and (f) beginning programming.

McCraw, an instructional designer, was hired to develop a computer program for both the Quaint City and Farther Out schools. Because of the different principals and structures of the two schools, only the Quaint City school computer program will be discussed in this paper.

The Quaint City school faculty is comprised of16 female teachers and one male principal. The student body consists of 250 students. In the initial meeting with the Quaint City principal, McCraw concluded that while the principal was aware of the benefits of students using computer applications, he had an incomplete perception of software integration. Although he understood the necessity for training teachers in the use of computers as a first step to software integration, he had not considered how that need could be met. McCraw suggested meeting the teacher training need in conjunction with the lab. Quayle was supportive of this procedure.

Based on McCraw's recommendations, the original grant goals and objectives were expanded to include basic computer education for the teachers. The program was developed based on two goals:

1. Teachers would be able to effectively use the computer lab after the Instructional Designer's one year term was finished.
2. Teachers would be provided inservice computer training within the framework of the school day.

These additional goals were broken down to include three instructional objectives:

1. Teachers would learn functions and operations of the Apple IIe and IIgs computers.
2. Teachers would be able to utilize computer tool applications for personal productivity and student instruction.
3. Teachers would be able to evaluate and select software that was well designed and would meet class curriculum objectives.

The method of instruction selected to accomplish the additional objectives was dubbed "School Day Inservice." This meant that teachers would be given basic computer instruction in the computer lab by the coordinator during the time their students attended computer classes.

Implementation of School Day Inservice

A meeting with the elementary school's five member computer committee and the instructional designer/lab coordinator was arranged by the principal. The intent of the meeting was to enlist the cooperation of the committee regarding inservice computer training for all teachers in the school. Prior to the meeting, the coordinator had compiled a catalog of the school's software to be distributed to the committee members. The catalog documented the subject, the grade level and a cursory description of each software application. It was used by the coordinator as a vehicle to put information in the hands of the staff and begin gaining their trust and support for the program.

During the computer committee meeting, McCraw proposed that teachers would have an opportunity for computer training during the school day, as had earlier been discussed with the principal. Committee members were agreeable to this concept. Members of the committee with the least amount of computer experience were the most enthusiastic about this opportunity for further computer training.

The computer lab had 10 Apple IIe computers, 2 Apple IIgs computers, and 3 ImageWriter II printers. Most of the computers were equipped to access a printer. One Apple IIgs has been specially configured with two 5.25" and two 3.5" disk drives for copying disks. The IIgs was dedicated specifically for the use of the classroom teacher when she visited the lab.

The attendance schedule for the computer lab had been arranged by the principal when making up the school schedule in the fall. Classes were scheduled to be in the lab three days a week for twenty minutes each. Teachers would be required to attend the lab with their students. During this period each teacher would preview software to become familiar with its content and assess its suitability for her students. The teacher would also be able to use this time to learn how to copy disks, utilize software productivity tools, or observe students as they interacted with the computers. In this arrangement teachers would have the advantage of having access to the computer coordinator if they encountered problems with the computer or had questions regarding the software. Also, teachers would no longer be isolated from communication and feedback in making decisions concerning suitable computer activities for their students, or in learning to use a computer themselves.

To prevent students from interupting their teacher's computer time, they were informed that their teacher was in the lab to work independently from them on the computer. All questions during computer lab should be directed to the computer coordinator.

Problems in Implementation of School Day Inservice

As with most new programs, School Day Inservice encountered problems with implementation. Problems could be categorized as those which were linked to: (1) delivery of hardware; (2) scheduling of students into the lab; and (3) two special situations. We will discuss each of these categories of problems.

Due to the last minute notification of the grant approval, ordering of the hardware, software, and even the employment of the lab coordinator were delayed until school began. At the same time McCraw was hired, the equipment was ordered. McCraw was immediately tasked with selection and ordering of software. The delay of the delivery of hardware gave her time to develop the software catalog, as well as a proposed curriculum for the teachers and students who would be attending the lab classes. The principal borrowed an Apple IIe from one of the classrooms so that McCraw could compile an inventory and review each piece of software in the school. A database of software was developed using *Appleworks* so that future acquisitions could easily be added to the list. Although this time was used advantageously, it contributed to the delay of the inservice. About a month into the school year the computers arrived, minus all of the disk drives. By this time McCraw and the principal agreed that classes must begin. Classrooms were robbed to equip the newly arrived computers with enough disk drives to begin classes on October first.

The second category of problems was generated by the lab schedule. Mr. Quayle had developed the lab schedule with one consideration in mind: that each student in school would attend the lab three times per week. Taking into consideration the usual scheduling conflicts related to sports, music, and other special classes, computer classes were scheduled from 8:30 until10:50 and from 11:40 until 1:35, with classes attending every twenty minutes. A planning period was inserted from 1:35 until 2:35 and the last class of kindergartners arrived at 2:35 and stayed until 2:55. It immediately became apparent that there was no time for passing between periods. This meant that the class and teacher must be standing in the hall waiting for the previous class to finish in order to receive their entire twenty minute lab time. There was barely even time for application switching, which was necessary about 4 times per day.

Inservice was therefore taking place under the constraints of : (1) timely arrival of the class into the lab; (2) the lab coordinator having their software selected and ready to use; (3) the class quickly oriented as to their task for the day; and (4) the teacher oriented to her task for the day. With a smooth transition, about five minutes was lost to either the arriving or departing class. If a teacher was delayed or forgot about the lab (which often happened) as much as half the lab period would be used before everyone was on task.

For kindergarteners and even second graders a 10 minute session would suffice. However, the third through sixth grades needed all of their lab time because they were sharing a computer between two students as touch typing classes began. This gave each student no more than 10 minutes per class time to practice typing. It was soon apparent to the lab coordinator that this was not enough time.

The ability to provide School Day Inservice depended on the ability to free the teacher during the time that her class was in the lab, but beginning typists could not be sacrificed for that reason. Therefore the next experiment was to split the classes so that no more than 10 students would come every other period and have the entire 20 minutes to practice one lesson of the typing program. This was a better arrangement for the teaching of typing but again delayed the School Day Inservice. Now all students, minus their teacher, would attend the lab for two class periods one week and for one class period the following week.

An exception was made for one particularly effective simulation, MECC's *Oregon Trail*. For this program, each class was brought back to the lab along with the teacher. Sharing a computer was not detrimental to the success of this application. Students were encouraged to plan their strategies together and take turns using the keyboard. The inservice could continue when programs other than the typing lessons were used. Since typing practice was essential for the beginning typists, the curriculum was again revised so that two days of the week could be devoted to typing by the students and on the third day, the entire class would attend with their teacher and use software other than the typing program. Inservice would now be conducted once a week. Although far from ideal, the network for communication was still in place and the teachers were free to preview software, watch while the coordinator conducted the lab, and otherwise become more familiar with the computer.

A final scheduling problem occurred when several of the more sophisticated simulations required more than the twenty minute lab period. A last compromise was that the entire class would meet on alternating weeks for forty minutes one of the three days to do a simulation. The remaining two days would be used by the split classes to continue to improve their typing skills. That still gave biweekly contact with the teachers and provided beginning typists with structured practice in typing skills.

Two Special Situations

Two special situations were encountered in the school. The first problem dealt with a class that was larger than twenty students and presented an immediate inservice problem. Because the fourth grade had approximately 27 students, each half of the class was assigned its own twenty minute lab period. It was virtually impossible to arrange for School Day Inservice for this teacher. She would always need to remain in the classroom with the other half of her class.

The other situation developed with the two kindergarten classes. From the first day it was apparent to the lab coordinator that these little ones were very dependent on their classroom teacher. She was in constant control of their activities and needed to monitor their needs in the lab. A few months into the program, these students were more independent and could now work without her constant attention, which freed her for some inservice.

Assessment of the School Day Inservice

As the six classes in kindergarten through second grade continued to attend the lab with their teachers, assessment of the value of the School Day Inservice could begin. One computer with dual disk drives was dedicated to teacher use. This meant that the copy utility was available while the lab was in progress. Often the teachers would come in to find disks, labels, and sleeves awaiting them. The teachers were shown how to use the copy program, label the disks, and insert the next disk. Other practice sessions included booting up the copy program and troubleshooting hardware connections. The majority of days these teachers spent previewing and selecting software. One example of the success of this venture was the MECC program *Right of Way*. This is a program designed to teach small children right from left. The first grade teachers decided that one part of the program would work and another would need further discussion. They decided to use the simple part for one 20 minute session and then take the program back to the classroom and discuss the next phase before trying it out in the lab. This combination of lab and classroom instruction proved to be successful.

Conclusion

Coming from an instructional design background, the authors realize that the perfect system has a built-in plan for continual assessment and revision. The perfect lab situation has to be tailored to the training needs of each school. The majority of the teachers had very little computer exposure; therefore, the presence of the computer coordinator for reinforcement has been vital to their training. As the teachers gain more confidence and experience, the role of the coordinator will be revised from trainer to consultant. Each school will necessarily have to experiment in order to find solutions that fit its own needs as this school did. The School Day Inservice is working for us for the moment, but at any time changes can be enforced to fulfill immediate needs.

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Utilizing Public Domain Software for a Teacher Education Technology Course

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Abstract

Technological advances are marking new ground on a daily basis. As state-of-the-art technologies emerge, universities must deal with economic realities that limit experiences for students. One primary concern is the lack of software available to support existing computer systems. This limitation compounds itself when course activities require that all students have access to the same software. One approach to this dilemma is to incorporate public domain and shareware software into the course design. This paper will differentiate between software classified as public domain and software that is recognized as shareware. A description of some of the available programs and a list of vendors to procure public domain and shareware software is also included.

As new technologies continue to be developed, universities are confronted with the realities of economics. Universities are not only limited in terms of hardware acquisition, but often are left with minimal software support for existing hardware.

Teacher education programs are encouraged to provide computer training for teachers. This results in a definite quandary. How can technology instruction occur with limited resources? In addition, public schools are faced with the same budget dilemmas. Often, software becomes the forgotten item of budget expenditures. Without software, technology is useless.

In order to provide a meaningful learning situation, students need to experience various capabilities of the computer for educational purposes. Students in a teacher education program should have experience utilizing the computer for word processing, data base management, spreadsheet applications, and production. In addition, they should view software that demonstrate instructional uses of the computer such as drill-and-practice, tutorial, simulation, educational games, and problem solving.

Public domain software and shareware software exist that will allow students the opportunity to evaluate the instructional uses of the computer as well as learn the skills of word processing, data base management, spreadsheet applications, and production. In addition to training teachers in the use of this software, there are other benefits that result from incorporating public domain and shareware software in courses.

Software can usually be categorized into one of three types: commercial, public domain, and shareware. Commercial software is published and copyrighted by the author and publisher, and a description of the copying restrictions is usually included with the software when it is purchased. Generally the software cannot be copied except for back-up purposes.

Software is called public domain if the author gives up his/her rights to the program. The user is free to make as many copies as he/she wants, or use the program in any way he/she sees fit.

Shareware is basically a simple concept. The authors of shareware programs retain all rights to the software under the copyright laws and simply allow distribution of their programs to be done freely or with few restrictions. The user may look at, copy, keep, or distribute this type of software freely. But, if the user decides to use the program, they are expected to register the product with the author. This fee generally provides the user with additional documentation and user support. It also provides for updates or other utilities from the author.

Utilizing public domain and shareware software eliminates the management concern of copying and distributing software. Students may take the software home to practice using it, they may use the software at their convenience at school and are not limited to class time for practicing their new skills. Students in courses are allowed to make as many copies of these programs as they wish which means they can then bring this software into their own classrooms and make as many copies as needed for their students.

There are currently good programs available for all types of systems either in the public domain or as shareware. There are programs for all topics generally covered in a technology course. Excellent word processing, database management and electronic spreadsheet programs can be found in the public domain or as shareware. There are simulations, tutorials, drill and practice and game programs available in most subject areas. In addition, you can find clip art for commercial programs like *Print Shop, Children's Writing and Publishing Center*, and *Express Publisher*. There are also numerous teacher productivity programs like shell programs, lesson plan programs, exam banks, grade book programs, etc. One just has to be diligent in looking for different types of software. Some examples of available tool software are described below.

Tool Software for the Apple

Word Processing. *FrEdWriter* is a public domain word processing program. The program contains the functions that are consistent with any word processing package. *FrEdWriter* allows the user to manipulate text by adding, moving, inserting, copying, searching, deleting, and changing text. Users can also find and replace text. Format options include justification commands, line spacing, margins, and pagination.

Word processing programs such as *FrEdWriter* can be used in introductory computer courses and teacher education technology courses to introduce students to the functions of a word processor. After students become familiar with the advantages of these programs, they can make copies of the programs to use as they complete their college course work. In addition, they can make copies to use in their classrooms with their students.

Data Base Management. *FrEdBase* is a basic data base program that allows the user to add, change, remove, search, and sort data. Students can create a database of a classroom to conceptualize the advantages of a data base program.

Electronic Spreadsheet. *The Spreadsheet* is a spreadsheet program that provides the same basic spreadsheet functions available in programs such as *Visicalc*. This program is an excellent means of introducing students to the advantages of spreadsheet programs. Students can create grading programs in order to manage data on their students effectively.

Tool Software for the IBM

Word Processing. *PC-Write Lite* is a shareware word processing program that contains all of the functions normally found in a full-featured word processing package. It is an entry level word processor that is easy to learn because of its on-screen help system. The program includes a 50,000 word spell checker.

Data Base Management. *File Express* is a powerful data base management program that allows the user to add, change, remove, search, and sort data.

Electronic Spreadsheet. *Express Calc* is an easy to use spreadsheet program that provides the same basic spreadsheet functions available in programs such as *Lotus 1-2-3*.

In addition to the tool programs described above, there are many types of computer software programs available free or for minimal costs. Below is a short list of vendors of public domain and shareware software. Check the advertising section of the major computer magazines for other sources of public domain and shareware software.

IBM Public Domain and Shareware

- Public Brand Software PC-SIG, INC.
  P.O. Box 51315
  1030 E. Duane Ave., Suite D
  Indianapolis, IN 46251

Macintosh Public Domain and Shareware

- Educorp Computer Services
  7434 Trade Street
  San Diego, CA 92121-2410
  1-800-843-9497

Apple II Public Domain and Shareware

- Gemini Marketing Inc.
  P.O. Box 640
  Duvall, WA 98019-0640
  1-800-346-0139
- CUE Softswap
  P.O. Box 2087
  Menlo Park, CA 94026

IBM, Macintosh, & Apple II Public Domain and Shareware

- Software Excitement
  P.O. Box 3072
  6475 Crater Lake Highway
  Central Point, OR 97502
  1-800-444-5457

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Computer Instruction and Preservice Teacher Education: One College's Experiences

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Abstract

As a result of receiving a grant from the IBM Corporation, the University of Wisconsin-Whitewater College of Education developed and implemented a computer education component for all preservice teachers. Issues that were addressed in setting up the program involved defining what knowledge and experiences were needed by preservice teachers and how these could be met within the limitations of time and facilities. An integration model was used. Students received instruction as part of an independent media course and in their methods classes.

Getting Started

The need to provide preservice teachers with instruction in computer education (and educational technology in general) is one facing colleges of education throughout the country. At the same time, funding for technology has become less available as many universities and colleges face cutbacks. At the University of Wisconsin-Whitewater (UW-W), an aging Apple IIe lab was technologically inadequate to meet the needs of faculty and students. While UW-W has a general computer facility, those labs and software did not meet the needs of the College of Education. In order to meet these needs, it became necessary to search for other sources of funding. Through the efforts of our Associate Dean, Dr. Ben Berhow and a committee of interested faculty members, a grant was submitted to the IBM corporation. After several discussions with IBM representatives about how we could assure that maximum use would be made of the equipment, the proposal was funded. The grant provided hardware, software, and training for selected faculty members. The hardware components included a networked lab with a Model 80 fileserver, fifteen Model 25 Workstations, and two IBM Proprinters. In addition, a Model 70 Workstation, a Model 50 Infowindow Workstation, an IBM Laserprinter and an IBM modem were provided. Software packages included Novell Netware, the ICLAS network management system, and approximately 100 instructional packages. During March and April, 1990, three faculty members received training at the IBM center in Atlanta. The week long sessions were for System Operators, K-8 Software, and 9-12 software.

The equipment and software began to arrive in February, 1990. The network was up and running by the end of May. The summer session served as an experimental period during which classes were given demonstrations in the lab as we learned how to use the network.

Planning the Program

The timing of the grant was advantageous since this coincided with an initiative from the Wisconsin Department of Public Instruction (DPI) which required all school districts in the state to have a written computer curriculum in place by 1990. Although we have an elective three credit computer course in the elementary/secondary curriculum, students who did not choose to take this course could graduate without any computer experience. The DPI requirement made it essential for us to provide our preservice teachers with computer experience if we expected to prepare them for entry into the teaching profession.

A College of Education Technology Committee was formed to discuss the planning and implementation of a technology plan for the college. The problems and issues we faced are probably not much different than those faced by other colleges with teacher preparation programs. We needed to determine what experiences would be necessary for our students and how we would provide these experiences. We began by asking several questions:

1. Are there some experiences that all students should have?
2. Are some experiences more important for certain groups of students (for instance, mathematics and science teachers)?
3. How could we effectively reach all students to provide them with the knowledge and experiences they needed prior to entering the teaching field?
4. What limitations would the availability of hardware and software place on our ability to meet our students' needs?
5. What role would the faculty play in this computer/technology initiative?

With an enrollment of over 2,000 undergraduate education majors, it was obvious that we did not have the staff or the facilities to have all students take a three credit required course. In fact, after discussing the issue, we decided that we would prefer to follow a model which integrates computer experiences into content instruction. This was consistent with the recommendations of the DPI. We agreed that all students should have experience with word processing and databases. In addition, students should have an opportunity to view and evaluate software packages that are used in conjunction with content area instruction.

In many instances, faculty members were not familiar with how computers could be used as a personal or instructional tool. Before we expect our students to use computers for instruction, we as faculty members need to model appropriate behavior. Faculty members were given demonstrations of ways in which they could produce class materials such as tests, overheads, etc. Instructors who brought their classes in for software presentations were given information before and after the class meeting so they could choose appropriate software. As they became more involved in using computers, they were enthusiastic about having their students use them.

What We Did

After several discussions, we decided to use a two pronged approach which included some skill development and some methodology. Since a one credit course, Individualized Production of Instructional Materials (ILSEM) was already a requirement for all elementary preservice teachers, this course provided a quick and easy opportunity to involve a large group of students in beginning computer experiences. In this course, students are expected to independently complete a number of modules relevant to the production of instructional materials. In the past, students spent time on activities such as using photography equipment, doing lettering, using slide projectors, etc. In the revised course, students are given an introduction to word processing, desktop publishing, and databases. They also have experiences with CD-ROM, videodisc, and telecommunications. Some activities are done on an Apple IIe or Macintosh as well as IBM.

Since many students had already completed their one credit requirement, another means had to be found to meet these students' needs. As part of our clinical experiences, a nine credit Methods Block (Reading, Mathematics and Language Arts Methods) is required prior to doing student teaching. Students teach classes at a local elementary school once a week and must hand in weekly lesson plans. We decided to require that all lesson plans used in this experience be done using a word processor. These students (approx. 100) received an introduction to the *Microsoft Works* word processing program. In addition, during the course of the semester, all methods block classes received a presentation of software appropriate to that content area and were given suggestions for integrating computer activities into their regular classroom instruction. Eventually, other methods classes such as Science and Social Studies also received software demonstrations.

In our present situation, students have approximately ten hours of computer related instruction as part of the individualized media course and ten to twelve hours in conjunction with various methods classes. Although this is not a large amount of time, it has given students a foundation that they can continue to build upon.

Current Directions

The 1990-91 school year was a time of tremendous growth and change as we tried to involve students and faculty in a variety of computer experiences. These experiences have helped us to get a better sense of where we want to go in the future. As a result of our experiences, we have developed a three stage model for technology. This model includes entry skills, a delivery system, and exit abilities. Since students come to us with a variety of backgrounds, we considered it necessary to articulate our expectations for skills that students should have prior to admittance to the College of Education. If students do not have these skills, it would be their responsibility to acquire them. Once in the College, they would be required to take the ILSEM course as before, but that course would be modified to reflect the students' higher level entry skills. Computer requirements for all methods classes would be increased with an emphasis on outside of class activities. Instructional support would be provided in the lab for these activities. Exit abilities would be assessed prior to graduation. Since we have not been in operation long enough to have this model in place, we are still in the process of defining exactly what these exit abilities might be and how we expect to assess them.

Plans for the Future

Plans for the future include the development of a one credit ILSEM course for secondary preservice teachers and an expansion of our graduate level offerings. A large number of IBM networks have been installed in our immediate service area and teachers have been asking for more courses that will help them use computers in the curriculum and for technical courses which will help system operators run their networks more efficiently. As part of our commitment to helping teachers, we have become actively involved in a Southeastern Wisconsin ICLAS User's Group which has become an excellent forum for sharing ideas and providing answers to common problems.

Although we are just in our second year of operation, we are already ahead of the timeline originally set up for the integration of computer experiences into the preservice curriculum. Other departments such as Educational Foundations, Special Education, Safety Studies, and Counselor Education have also started to make use of the lab facilities. As we continue to grow, the demand for resources will increase. We are encouraged by our success in involving students and faculty in using computers for instruction and look forward to continued growth and accomplishments.

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Successful Strategies for Increasing Technology in Preservice Programs

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Abstract

This paper will review the need to integrate technology into preservice programs, describe current conditions that have been found in preservice programs, and detail successful strategies for integrating experiences with technology into preservice methods classes.

Introduction

This paper will review the need to integrate technology into preservice programs, describe current conditions that have been found in preservice programs, and detail successful strategies for integrating experiences with technology into preservice methods classes.

Few will disagree that the impact of technology on all our lives will continue to increase. Consider then, the students that are graduating from teacher training programs throughout the United States will be in classrooms, impacting on students, for the next thirty years. With that thought in mind, we must ask ourselves whether these new teachers, and those to follow, are being trained to use technology in their own teaching; are they being trained to prepare their students for the role technology will play in their lives? In a recent national survey, less than one-third of the education majors who responded perceived themselves prepared to teach with computers (U.S. Congress , 1988).

Current Conditions

Despite the growing need for technology training, there is little evidence that typical preservice education programs are permeated with opportunities to work with technology (Bruder, 1991). Kozma and Johnston (1991) noted that technology can facilitate the achievement of goals in higher education but that it requires considerable effort on the part of those who would be helping students to use them. Teacher education programs have the responsibility to ensure that future classroom teachers can make use of the technology available to enhance student learning. Currently many K-12 districts are ahead of university preservice programs in the professional development of currently faculty in the area of incorporating technology into their instruction (Fratianni, Decker, & Korver-Baum, 1989). It is important for teacher education programs to take an initiative in order to better prepare new teachers.

In some teacher education programs a required introductory computer course has been developed, in others an optional course is in place. These courses generally introduce some tool or applications software, provide an opportunity to evaluate Computer Aided Instruction (CAI) software and perhaps include an introduction to programming. Rigid program sequences often limit the amount of computer preparation that may be available to a student. As a result, it is not uncommon for this microcomputer training to be compressed into a single course (Criswell, 1989). In addition state certification mandates may limit the number of electives students have available for coursework in the instructional use of computers. Computer courses are frequently taught by technology specialists and often do not focus on the use of application or CAI software in an instructional setting. Further, there is little attempt to integrate the technology into the content areas. Integration of computers into the methods blocks provide one of the best opportunities for introducing the uses of technology in an instructional setting (Niess, 1990).

We teach as we are taught. It is important that future teachers observe technology being used for instruction, see their own professors modeling what they will be expected to do in the future. Strudler (1991) describes his own involvement in modeling lessons incorporating the computer for various education courses. His experience has been that attending faculty see value in using the computer in their own teaching as a result of these sessions. Many teachers of the methods courses have not yet developed their own expertise with technology. How can an institutional structure provide an opportunity for faculty members who work across disciplines to help each other grow professionally, to the benefit of both faculty members and students?

Supporting Strategies

Lack of comfort with technology is not synonymous with lack of interest in or lack of recognition of the need to provide computer experiences for preservice students. Almost all college faculty expect students to use word processing for their assignments. This experience develops teacher comfort with the computer as a personal tool, but does not help in developing comfort with it as an instructional tool. It is difficult for those who have gained expertise in their own fields, and who continue to maintain that expertise, to be asked to learn other new material and new ways to teach old material (Goodson, 1991). In the remainder of this paper I will discuss successful strategies that have been used at National-Louis University to support faculty members in integrating technology into preservice courses.

Methods Classes

In our institution, members of the Computer Education Department have had an opportunity to co-teach and plan lessons using the computer with colleagues who are not as comfortable with using the computer in their instruction. A range of activities have been developed in conjunction with these colleagues to support methods courses in social studies, language and reading, and mathematics methods. Through these activities both the students and the faculty become more familiar with both the existing software and the ways in which it can be used.

During the undergraduate language arts methods class, the instructor determined that students needed to learn about word processors and spell checkers for themselves. The instructor asked me to plan a session in the computer lab where the students could see a demonstration of several word processing programs and spell checkers that were available for their use.

In the graduate level section of the same course, the students were more familiar with personal use of the word processor. In that class, a range of word processors was demonstrated, those appropriate for use in the lower elementary grades, the middle schools and the junior high school student. In addition, other programs for use in language arts were introduced, such as *Children's Writing and Publishing Center* and *Pelican's Big Book Maker*. The software was loaded on computers in the lab, and time was provided for pairs of students to explore several of the programs that had been demonstrated. Sessions of this type have been planned several times, and each time the faculty member becomes familiar with more of the available software.

Joint planning with social studies methods teachers has resulted in two different kinds of student sessions. One of the teachers is now developing similar sessions; another still requires support. Such support can only result in better preparation for the future teachers in that class. One of the sessions developed for social studies is held in the classroom and includes software demonstrations as well as video tape segments of successful use of computers in the one computer classroom. The second session is geared toward student exploration of the software. After the methods teacher has introduced the design of the lessons plan, students go to the lab and preview a potpourri of previously selected software. They, again in pairs, select a piece of the software and determine the way in which it might be integrated into a lesson plan.

Each of the cases above is a step towards increasing the use of technology in the preservice program. But they do not address the major problem of having these students see the use of the technology modeled for them to any degree. That is the next step in the process and is only used by those faculty who are most comfortable with computers.

The reorganization of several departments into one division has provided a vehicle for faculty to share how they are using technology. Demonstrations by willing faculty from each of the departments was the focus of one division meeting. It was an opportunity for a science methods teacher to demonstrate how he used a program on color and prisms for direct student instruction and telecommunications to download weather information.

Another member of the division described how telecommunications is used as a tool to enhance the writing process. Her discussion included ways in which it was used for both preservice and inservice teachers. The videodisc and HyperCard have provided a new teaching tool for a member of the mathematics education department. This kind of sharing has become a catalyst for collaboration among a variety of faculty members. It also allows members of the Computer Education Department to support colleagues who are more reluctant to make these first attempts.

Other Class Settings

Prior to student teaching, students observe in classrooms for 100 hours. These observations are a part of the elementary education preclinical experience and are required in both the undergraduate and graduate level programs. It is not uncommon for these students to have had little, if any, experience with the instructional uses of computers. Faculty supervising this course determined there was a need for these students to have some preparation for observing technology used in the classrooms they were to visit.

A special session was designed for these students. The session began with a short discussion and demonstration of the different kinds of software they might see in use. This included application, utility and CAI software. They then viewed one of the demonstrations of software in use produced by Sunburst. Following this there was opportunity for them to ask questions about what they had seen. The response from these students indicated this session made their observations more meaningful. We plan to offer a similar session again during this school year.

Additionally, current plans are being put in place to work with the student teaching seminar faculty to design technology experiences for their students. These opportunities will include viewing of video tapes of "real teachers" using technology, using prepared video tapes from software producers and discussing instructional uses of computers. We will also introduce student teachers to a variety of software and the different instructional modes they invite, and work with them on building lesson plans which integrate a particular piece of software. In each of these settings the faculty and the preservice students are becoming aware of the ways in which technology can be integrated into their instruction.

It is the goal of the student teaching supervisors to discuss specific content lessons and provide demonstrations of how technology can be integrated within those lessons. Some of the sessions planned include the use of *Children's Writing and Publishing Center* for newsletters, the printing of a big book and the use of the laminator, and previewing of software so that they may plan (and hopefully, present to the group) a lesson for the one computer classroom.

We are trying, as we hope these examples demonstrate, to open the door for both the preservice students and their teachers to the ways in which technology, specifically computers, can enhance instruction.

Conclusions

Why should we in teacher education not take advantage of what we know about good staff development in the schools? We know that discussion, evaluation, collaboration and encouragement are all part of a well planned experience in professional growth. Using the model of peer support described in this paper, university faculty and preservice students can benefit by increasing their own knowledge and efficacy. The beneficiaries will be the young students in our schools for many years to come.

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Young Children As Teachers Of Computing

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Abstract

To introduce early childhood education students to the uses of computers with young children, a series of activities for a Language Development course were designed and implemented. Students were required to locate a piece of developmentally appropriate software for children (ages 2-6), and in a formal or informal setting, observe and interact with a child using the computer with that particular software. This paper describes the results of this computer activity and summarizes the knowledge gleaned by both instructors and students from these exercises. Specific attention is paid to the use of young children as tutors as a bridge of opportunity for the education students to translate abstract educational theories into practice.

Introduction

Because current hiring practices regarding newly-trained teachers frequently include screening for computer literacy skills and some level of knowledge concerning educational computer applications, computer skills have become an essential component of teacher education programs. Most schools of education have revised their curriculum for this need, and many states now mandate that every student in teacher education take one or more courses in the instructional uses of microcomputers. Universities have designed courses specifically to meet such mandates, and in many colleges of education, these have become the most popular offerings in the curriculum (Bullough & Beatty, 1991). In addition, some teacher training institutions are taking the imaginative step of incorporating computer applications into methods courses, providing students with opportunities to use computers as instructional tools in their particular subject areas. The philosophy behind this approach is that once a student becomes familiar with using computers for instructional purposes in their particular subject areas, they are likely to continue to use them to resolve problems they encounter later in their own classrooms.

It is this latter philosophy that the authors of this paper adopted when designing a computer-oriented approach to the Language Development course at Bucks County Community College in Newtown, PA.

Background Information

Bucks County Community College, in its efforts to prepare its students and faculty for the 21st century, has directed some of its education efforts to include the new technology across the curriculum. Due to the resources provided by a Department of Education Title III grant, selected faculty members were encouraged to use Macintosh or IBM computers within their specific disciplines. By providing such resources as technical support, hardware, software, faculty development opportunities, release time from teaching, and structured workshops, it was expected that faculty would attain a degree of comprehension and grow in understanding about the complexity of and pedagogical potential inherent in new educational technologies. Participants in this project were expected to maintain a log of computer-related activities (reading, computer created hand-outs, record of student tasks, and training of colleagues), attend training sessions, and provide the Director of the Computer Project with regular reports.

The "Language Development" Course

The Education Department was one area selected for participation, and a Language Development course was targeted by a faculty member (Dr. Maxine Hirsch) for computer intervention. This Language Development course is part of an Associates Degree program in Early Childhood Education at the community college. This occupational program of study, which is licensed by the Private and Academic Agency of the Pennsylvania State Department of Education, frequently is selected by the recent high school graduate or the mature student who is seeking a career option. Courses specific to the early childhood field, such as observing the behavior of young children, art and music for young children, math and science for young children and language development compose the body of this course of study. A catalog description of the targeted course states:

An exploration of language development in young children from infancy to eight years of age. Planning and representation of appropriate activities are emphasized in areas of experiencing, listening, speaking, reading and writing. Primarily for initial and or permanent certification in early childhood education, but also of value as an elective course for parents, elementary education majors, instructional assistants and students seeking a nursing degree (Bucks County Community College Catalog, 1991-92).

When planning the technological intervention, the professor considered the following issues: the nature of the community college student; integrating computers into the course content; hardware and software availability, student and teacher technophobia; in-class computer activities; student assignments; and measurement of student learning[1]. The following session summarizes the process of integrating computers into in the Language Development course.

The Technological Intervention

The purpose of the assignment was for students enrolled in the "Language Development" class to interact with a computer and a piece of *developmentally-appropriate* software to attain: (1) a basic degree of comfort, familiarity and insight into using the computer for educational purposes; and (2) some comprehension of its potential usage as a communication tool for young children. To accomplish these goals, students were requested to locate a piece of software that was appropriate for a young child (ages 2-6)[2]. In a formal or informal setting of the student's own choosing, she was to observe and keep notes on the child using the computer. Specifically, the student was to analyze the child's:

- language and thinking processes
- facility with the computer
- response to the specific software

By using 5x8 index cards, the students were to keep a running record of their involvement with the computer activity. These cards were later supplied to the instructor for review and evaluation.

As the semester progressed, it became apparent to the instructor that the students were not becoming adequately involved with the computer activity. Several negative aspects were at the center of this problem, including: the lack of software availability, innovative nature of the assigned task, computer fear, lack of technological resources, or a lack of organized computer time. In order to save the situation, and in consultation with each other, the professor and the educational technologist did arrange to provide the class with a series of four computer-active classes in which the students would have hands-on instruction. To increase access to software, one student placed five programs of her own on library reserve, and her peers were able to borrow these programs. These two activities appeared to solve several of the students' expressed problems with the assignment, and they were able to proceed with the exercise.

Instructor's Comments

In retrospect, the most important activity for the class involved the loan of representative five year olds from the Early Learning Center, a campus childcare facility, to attend one of the four computer-active classes. These young children were made available for students for "study" in the computer lab as they interacted with such age-appropriate software programs as *Reader Rabbit, Playroom*, and *Face-Maker*. The children provided the Language Development students with an in-class opportunity to conduct research on young children's interaction with the computer. However, something even more noteworthy occurred in this part of the project. In effect, these young children became the *teachers* for the students; through observing the children's lack of fear, rapt attention to the screen activities, engagement on task, and facility with the computer interface, college students began to realize the power and potential of computer instruction.

Essentially, what was discovered was that learning roles were reversed, as Language Development students became recipients of knowledge generated from the young child's naive interaction with the computer. Children, through their natural curiosity, exhibited no inhibitions caused by expense or expanse (money or machine). Specifically, abstract theories about children and computers were translated into reality through this in-class exercise, as children provided the bridge of opportunity for the college students to exchange any pre-formulated notion of "who is teacher" and "who's in charge."

Implications for Children as Tutor

While the practice of children-as-tutors is not in itself a revolutionary concept, we feel this represents a novel approach to teacher training. As reflected in student reports, and instructor's perception, this serendipitous activity proved to be the major discovery in the introduction of computers into the Language Development course. While various threads from this activity have been woven into two early childhood courses Fall semester 1991, fuller implementation of the child-as-tutor concept will occur in Spring and Summer of 1992 in a newly revised course, Computers, Media and the Teacher, co-taught by the authors of this paper. In this course, children and college students will work in partnership on such activities as: examining educational software, constructing criteria for effective software, creating text and graphic documents, and mocking-up sample software screens. Through these activities, it is our intent to have college students gain insight into children's activities with computer technology in a authentic environment.

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[1] A second article is being completed that explains the thought-process used by the instructor to determine the appropriate technological intervention for this particular course/students. Those readers interested in this process can contact the authors for more information.

[2] Sample programs identified included *Playroom, Reader Rabbit, Facemaker.* etc.

Automating Student Teaching Evaluations Under NCATE Standards

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Abstract

The 1990 National Council for Accreditation of Teacher Education (NCATE) standards call for the establishment of systematic procedures for monitoring student progress in clinical and field-based experiences. Such procedures should include collecting information about student performance while they progress through their particular programs and demonstrate the various competencies learned in their coursework. In typical Colleges of Education, the most significant opportunity for observing Teacher Education Students is when they practice these teaching competencies during the student teaching experience. Because of their efficiency, flexibility, and cost-effectiveness, computing technologies represent a logical choice for data collection, analysis, and management. The purpose of this study was to (1) present a new follow-up model that complies with NCATE Standards for monitoring student progress and follow-up, and (2) describe how automated data collection and management devices can be used to increase the efficiency of student performance data collection and analysis.

Introduction

The 1990 National Council for Accreditation of Teacher Education (NCATE) standards call for the establishment of systematic procedures for monitoring student progress in clinical and field-based experiences. Such procedures should include collecting information about student performance while they progress through their particular programs and demonstrate the various competencies learned in their coursework. In typical Colleges of Education, the most significant opportunity for observing Teacher Education Students is when they practice these teaching competencies during the student teaching experience. At the University of West Florida (UWF), student performance data are collected on the target teaching competencies (27) as identified by the State of Florida and the College of Education.

NCATE Standard II.B "Relationships with Graduates" provides for the gathering of data from graduates which would be used to improve the quality and efficiency of the Teacher Education Program. These new standards require that alumni follow-up data be used by the institution for systematic, formative program evaluation and refinement. This represents a shift from summative to formative evaluation for how alumni follow-up data are to be used within an institution. Therefore, the form in which the data are made available and the speed and ease with which they can be retrieved are important determinants of how feedback will be used. An automated data management system will assist program evaluators in their assessment of the effectiveness of teacher preparation programs.

Because of their efficiency, flexibility, and cost-effectivenss computers represent a logical choice for data management. Large volumes of data can be accessed and analyzed quickly, information can be reorganized in alternative easy-to-use formats, the data base can be updated as new information becomes available, and changes to academic programs based on feedback can be recorded and tracked to determine their effects (Burnside, 1983). Minicomputers and supporting equipment will allow program evaluators to organize, analyze, and integrate data more efficiently, and this in turn, will lead to more effective decision making based upon feedback. The purpose of this study is to (1) present a new follow-up model that complies with NCATE Standards for monitoring student progress and follow-up, and (2) describe how automated data collection and management devices can be used to increase the efficiency of student performance data collection and analysis.

Follow-up Models

An introduction to and discussion of various follow-up models is necessary to fully appreciate the variety of methods used, and to serve as a basis of comparison for the UWF model. All of the models reviewed described the varying degrees of time, resources, and manpower required to effectively evaluate graduates of Teacher Education Programs.

Borich (1979) presents three methodological models that can be used to conduct follow-up studies of preservice and inservice teacher education and training. The needs assessment model (Borich, 1980) is a self-evaluative procedure which relies on judgements of teachers about their own performance. Goals and objectives are presented in the form of competency statements and then assessed to determine whether they have been met. Evaluation is complete when the training program has objectively determined the discrepancy between what the teacher should be able to do and what the teacher can do. The needs data can then be used to make either formative or summative judgements about the training program. Implementation is easy, results are easily interpreted, and the addition of supervisor-administrator ratings or limited follow-up visits enables it to be more objective.

The relative gain model (Borich, 1979) assesses relative pupil improvement. When potentially confounding variables are statistically controlled to an extent that allows the effects of teacher training to be measured in units of pupil performance, then teacher competencies can be translated directly into pupil competencies. Valid measures of relative gain are obtained through the use of criterion-referenced tests and the clustering of competencies. The model can be used continuously to check the effectiveness of a training or education program, and can be based on three units of analysis including the classroom, school or school district. In addition, the model can accommodate new information about pupils, teachers or schools. Despite its flexibility, the model remains time-consuming and requires much manpower and expertise.

The process-product model (Borich, 1979) tests the appropriateness of behaviors taught to teachers and determines to what degree the program can produce appropriate behaviors in teachers. The objectives and rationale of the teacher education or training program are the framework in which the process and product behaviors are measured and correlated. The evaluation will determine the validity of the rationale or theory underlying the program. Although the model serves the teacher trainer and researcher, it requires extensive instrumentation and considerable human and fiscal resources.

Tennessee Technological University (1987) created and implemented a follow-up model in 1973 that provided input from graduates of teacher education programs, their supervisors, and students and independent observers. Each fall 60 graduates were selected to participate in the evaluation project, and subgroups of graduates had data collected on them for at least five consecutive years. During their first year of participation, graduates completed the California F-Scale Forms 40 and 45, a self-rating device of the achievement of the objectives of the teacher education program, and a questionnaire designed to collect demographic information during their first year of teaching. Trained research assistants made visits to the schools of the graduates one or more times a year to collect information about the graduates' performance. The results of this 13-year study were used to improve the university's teacher education program.

Galluzzo (1982) presents a comprehensive four-part model which consists of admissions, process, product and follow-up. Data is collected from the time students are accepted into the professional education program and continues three years after they have graduated. Two methods are suggested for collecting data during the follow-up studies, in situ observation and a mailed survey. During the first year, data is collected on a sample of graduates who are observed using an instrument that will be used throughout the program. Changes in teacher performance can be measured over time and student-teaching observations can be compared with follow-up observations to reveal shifts occuring in practice. The model requires that in situ observation be a part of student-teaching and follow-up. A mailed survey is given to a sample of third year teachers to assess their perceptions about the training program and its relation to teaching. The competencies used as the outcomes of the teacher education program serve as the items for the survey. Galluzzo suggests that the survey should reveal teachers' perceptions on three points: 1) the importance of each competency in their present position; 2) the degree of difficulty they have in performing the competency; and 3) teachers' ratings of their undergraduate preparation for each competency.

Method

Sample

The sample for the study consisted of 188 university coordinators who observe student teachers during their training program, 189 supervising teachers who work directly with the student-teacher in the classroom, and 189 student-teachers.

Procedure

Data on the 27 teaching competencies are gathered three times over the semester: the mid-semester report, three student-teacher observations, and a student-teaching final evaluation. Each of the sources include ratings of student performance on the 27 specific competencies. For this study, the final evaluation of the fall 1990 semester from the three groups was used.

Instrumentation

In the fall of 1991, major changes related to the student-teacher assessment procedure were initiated. Initial efforts concentrated on examining the content validity of the competency rating form and its current scaling. The respondent uses a three-point Likert scale indicating the degree to which a particular competency was demonstrated (e.g., 1 Outstanding Performance, 2 Acceptable for this level of Competence, 3 Needs additional development, and 4 Not Observed). While narrative descriptors are also used, most of the instrument consists of district teachers, student, and faculty ratings of student-teacher performance on the 27 competencies of Florida's Beginning Teacher Program. The items themselves are based on the 27 teaching competencies and are organized into three sections: Professional Qualities (12 items), Classroom Management (5 items), and Instructional Skills (12 items).

Statistical Analysis

Reliability of the instrument was determined using the Cronbach alpha internal consistency coefficient for the three subscales and the total instrument within the three groups. Exploratory factor analysis was also used within the three groups to summarize the patterns of correlations among the items to determine if three factors (Professional Qualities, Classroom Management, Instructional Skills), do indeed, exist.

Results

The results of the reliability determination for each subscale and the overall instrument are summarized in Table 1. In the table, S represents the student group, T represents the supervising teacher, and C represents the university coordinator beside the items of the final evaluation. As indicated in the table, all of the scales had good internal consistency reliability within the three groups. Results of the exploratory factor analysis are also presented in Table 1 for the three groups. Under each symbol are the loadings of the item on the designated factor within each group. The only subscale that demonstrated factor structure replicability across the three groups was Classroom Management. Professional Qualities and Instructional Skills failed to replicate across the three groups and are seriously confounded with each other. It was determined that the weak factor solution was caused, in part, by inadequate scaling. Thus the scaling was expanded to four (e.g., 1 Weak demonstration of the Competency to 4 Excellent demonstration of the Competency) and the first four items, which did not specifically represent competencies, were dropped. Efforts are now underway to clarify the factor structure of the instrument.

The University of West Florida (UWF) designed a follow-up study model in 1991 which collects data from graduates for three consecutive years after their completion of the Teacher Education Program. Graduates participate in the follow-up study during their Beginning Teacher Program (BTP) year and three years thereafter when they are eligible for a professional contract. They will provide information pertaining to the 27 target teaching competencies and attitudes instilled by the program. Automated data collection and management devices will be used to link skills and attitudes as measured in the student teaching experience with similar teaching behaviors and attitudes of first-year and experienced teachers who graduate from UWF programs. A representation of the model is presented in Figure 1. Analyses will consist of performing a repeated measures MANCOVA using the preservice year as a covariate for statistically controlling for initial differences in the groups. The independent variables are time (Year 1 through 4) and group (Students, Supervising Teachers, and University Coordinators. The dependent variables are the three subdomains of Professional Qualities, Classroom Management, and Instructional Skills expressed as both competencies and attitudes. Post-hoc comparisons will then be conducted to compare the performance of years 2, 3, and 4 to the preservice years to determine program effects.

Another major effort will involve converting the manual student data collection and storage procedure to an automated process. Until the fall of 1991 all student teaching evaluation data had, as a rule, been used for assigning a grade or advising the student, then was stored

Table 1

Reliability and Exploratory Factor Analysis Data for Three Groups

PROFESSIONAL QUALITIES	**S**	**T**	**C**
Commitment to teaching.	.66	.66	.82
Adequate health and vitality.	.57	.57	.34*
Maturity of judgment and ability to make realistic decisions.	.38	.38	.45
Proper perspective of teaching©learning situations	.32	.32	.47
Ability to comprehend and interpret professional material.	.30*	.30*	.37
Works cooperatively with other staff members.	.70	.70	.52
Reflects feeling for the dignity and worth of people from all ethnic cultural, linguistic and economic groups.	.67	.67	.59
Aware of patterns of physical and social development in students.	.10*	.01*	.11*
Ability to orally communicate information on a given topic in a coherent and logical manner.	.33*	.33*	.41*
Ability to write in a logical, easily understood style with appropriate grammar and sentence structure.	.40	.40	.10*
Instructional and social skills which assist students in developing a positive self concept.	.42	.42	.63
Open, flexible teaching personality.	.41*	.41*	.55
Cronbach alpha internal consistency	.91	.85	.92
Total	.96		
CLASSROOM MANAGEMENT			
Formulated a standard of student behavior in the classroom.	.54	.54	.76
Competence in classroom management.	.68	.68	.89
Fair and just attitude in dealing with students.	.55	.55	.41
Establishes rapport with student by using verbal and/or visual motivational devices.	.68	.68	.40
Clinical approach to misbehavior.	.61	.61	.63
Cronbach alpha internal consistency	.92	.89	.92
Total	.96		
INSTRUCTIONAL SKILLS			
Command of subject matter.	.50	.50	.07*
Identifies long range goals of subject area.	.63	.63	.56
Diagnoses the entry knowledge and/or skill of students for a given set of instructional objectives using diagnostic tests, teacher observations, and subject records.	.66	.66	.69
Developed/sequenced learning activities appropriate for instructional objectives and student learning needs.	.59	.59	.44
Prepares effectively for lessons.	.39*	.39*	.16*
Motivates learners.	.17*	.17*	.14*
Presents directions for instructional activity.	.36*	.36*	.18*
Performs a variety of critical teaching tasks.	.47	.47	.28*
Identified/developed a system for keeping records of class and individual student progress.	.70	.70	.79
Competence in the evaluation of students.	.58	.58	.64
Counseled students both individually and collectively concerning their academic needs.	.57	.57	.84
Ability to profit from feedback.	.05*	.05*	.17*
Cronbach alpha internal consistency	.92	.89	.95
Total	.97		

* items that are complex with another factor.

NCATE Follow-up Study Design

	Preservice	Time BTP	Teacher	Teacher
	Year 1	Year 2	Year 3	Year 4
		Competencies		
Students	Prof. Class Instruc.	Prof. Class Instruc	Prof. Class Instruc.	Prof. Class Instruc.
Supv. Teach.				
		Attitudes		
Univ. Coor.	Prof. Class Instruc.	Prof. Class Instruc.	Prof. Class Instruc.	Prof. Class Instruc.

Figure 2. NCATE Follow-up Study Design

in file cabinets on either microfilm or in paper form. In an effort to comply with NCATE standards for monitoring student progress and follow-up, and to increase the efficiency of student performance data collection and analysis, the system was redesigned as follows: 1) The Student-Teaching rating form of the 27 teacher competencies was redesigned into a mark sense form which will be scanned directly into a raw data file; and 2) the data collected will be integrated into reports which faculty could then use to modify their programs. NCATE Standard III.B "Monitoring Progress" provides for the gathering of data from graduates which would be used to improve the quality and efficiency of the Teacher Education Program. The Follow-up Committee at UWF has created a basic design for the follow-up procedure. This effort involves using automated data collection and management devices to link skills and attitudes as measured in the student-teaching experience with similar teaching behaviors and attitudes of first year and experienced teachers who graduate from the UWF programs.

Conclusions

The National Council for Accreditation of Teacher Education calls for a systematic process of gathering follow-up information which provide understanding of how well the teacher preparation program is working. The process of documenting student teacher performance, collecting and analyzing program performance data, and applying results from follow-up studies is the primary rationale which drive changes in the Teacher Education curriculum. NCATE Standards specifies from where this information should come and what types of program changes may result from this feedback. Teacher preparation programs which have reported results of their efforts and follow-up models presented in this study reveal several common characteristics.

The process of implementing a follow-up program can be time-consuming, require considerable human and fiscal resources, and must be done over a long period of time. Moreover; instruments used to measure differences in teacher competencies as taught in teacher preparation programs compared to teacher competencies as observed in teaching situations can be described as not very reliable or content valid. A logical consequence of determining that the follow-up task must be done to improve the quality of the teacher education program as well as to comply with the NCATE Standards is to seek ways to automate as much of the process as possible. The goal should be to increase accuracy and reduce human effort in handling the data.

At the University of West Florida the search for means of automating has lead to a number of design changes which alters the way follow-up activities are viewed and implemented: 1) student teaching has been identified as the single most important point in the teacher preparation program which could provide comprehensive and critical information about program effectiveness, 2) information collected during student teaching will be stored in a data base and then will be used to link and compare student performance before and after the student teaching experience, 3) evaluation forms and data collection procedures must be redesigned to formats which are conducive to including machines as workers, 4) data related to the student teaching experience must be collected on machine readable forms, and 5) data that is separate in time and space must by linked through computer programs to give new meanings to information about the students' performance and the Teacher Education program.

In order to extract accurate meaning from student teaching behaviors, data must be collected from the student, the supervising teacher, and the University Coordinator. Information must focus on the behaviors identified by the program as target competencies and which the student has been taught in the teacher preparation program. This means that the information must be timely, accurate, and complete. At the University of West Florida it must also be consistent with NCATE Standards.

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Why I Teach Logo to Teachers

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Abstract

Teachers who participate in a course in Logo programming learn valuable lessons about the experience of being a learner. They gain insights into their own problem-solving strategies as well as develop an appreciation for the value of mathematical information. Alternative roles for teachers, as coaches and facilitators, are modelled during the course. The newness of Logo as content provides an arena in which these topics necessarily arise. Emphasis in the course is on the processes of teaching and learning, as illustrated by teaching and learning Logo.

There are two questions embedded in the title of this paper: "Why do I teach Logo?" and "Why do I teach Logo to teachers?" I teach Logo because it is a well-designed programming language with an easily learned operating system with "no threshold, no ceiling." Logo provides accurate representation of the relationships among numbers and a context in which those relationships matter. Logo gives an intuitive experience with geometric figures that can serve as a precursor to formal axioms and theorems (Bruner, 1960). Logo makes accessible a rich source of interesting problems to solve, rather than a rigorously sequenced set of mathematical exercises. For all these reasons I recommend and choose to teach Logo rather than some other programming language.

But why do I teach Logo to graduate teachers who do not intend to teach programming to children? I use the effort of learning Logo to open up a dialogue with teachers in weekly journals, a dialogue in which we exchange views about theories of learning and about classroom practices. Whether a teacher will be using the subject matter of Logo after completing my courses or not, the process of learning Logo is a valuable one.

Insofar as computers can be used in efforts to rethink curriculum and schools as we know them, teachers are the only legitimate, lasting source and catalyst of change. "One could conclude, then that genuine changes will come about when teachers think differently about what is going on in their classrooms, and are provided with the practices to match the different ways of thinking" (Richardson V., P. Anders, D. Tidwell, & C. Lloyd, 1991). Process writing is one good example of this sort of change, not only in the ways teachers think about language learning, but also in the ways they organize the practice of writing in their classes. Teachers learn to do this by becoming process writers, by learning what process writing feels like — inside the activity itself. Logo is another such practice, and it can be used to illustrate a different way to think about what goes on in a classroom, especially a mathematics classroom.

My Goals For Teachers

I teach Logo to teachers to accomplish a variety of goals with teachers as learners as well as with teachers as designers of educational environments. There are other subjects that can be used to achieve these ends, perhaps. But Logo works wonderfully.

Teachers as Learners

The process of learning Logo makes accessible to teachers "metalessons" about what it feels like to be a student, solving a hard problem of one's own choosing, feeling bewildered, frustrated, insecure, and finally triumphant. I submit that learning Logo will serve to do the following:

1) **To reintroduce teachers to their own learning styles.** In journals, teachers tell me that they are meticulous or slapdash, planners or experimenters, courageous or timid about learning Logo. They tell me the methods they have to use in order to learn Logo. I lecture and demonstrate, and I also provide text which covers the same material. They ask me whether they should read the material before coming to class, or take notes in class before reading the material. I tell them to figure out what works best for each of them and to do that.
2) **To provide opportunities for teachers to experience learning a new skill.** Logo is not like any other content that teachers have learned. It demands new ways of thinking, problem-solving approaches that are unfamiliar, and social arrangements that may seem awkward at first. I encourage teachers to work in pairs and to experience the value of collaborative learning. I also encourage them to write about their interactions and examine them. I remind them that whatever they are feeling as they work within the group on this new material may well be a feeling shared by children in their classrooms
3) **To provide a positive mathematical experience.** Many of my teachers tell me that they were "no good at mathematics." My lessons involving formulae for right triangles and the circumference of a circle are initially met by groans of unhappy recognition. Logo as a subject provides an open field in which mathematical truths (like the factors of 360) are not mines or booby traps, but are rather tools for accomplishing goals. As they work on their programming projects, teachers come to appreciate these tools and their own surprising ability to use them.
4) **To build teachers' problem-solving skills.** Teachers who program in Logo learn to use, to value, and to teach problem-solving skills. Much of our dialogue in teachers' journals consists of my encouragement as teachers struggle to create midterm pictures of their own design. I talk to them about defining a problem in such a way as to make it easier to solve, choosing a starting point that simplifies rather than complicates the process.
5) **To demonstrate the value of revision.** Together in class we construct procedures step-by-step. Sometimes these procedures are not elegantly or economically written, but they provide a starting point. Then we discuss revising our procedures to make them more streamlined. Teachers begin to appreciate the difference between what I refer to as "brute force programming" and elegant, top-down programming. They understand the value of rewriting procedures to make them cleaner and neater.
6) **To demonstrate the possibility of learning from errors and the value of cognitive dissonance.** I do not attempt to protect my students from all errors. They learn to value mistakes and see themselves learning from their mistakes as well as those of their classmates. I suggest that their students, too, need not be protected from every possible error. In their journals, they report that they thought they understood the lesson as I was teaching it, but in fact that was not so. I encourage my teachers to predict what a procedure will do and help them to analyze the differences between their expectations and actual outcomes. They tell me that when the procedure did not run as expected they were forced to pay attention to the language more closely and then understood concepts more completely.

Teachers as Designers of Educational Environments

The graduate teachers who take my course vary dramatically in ability, not only in mathematics, but also in art and music. The reality is that I am only one of many experts in the class. Teaching Logo provides me with a forum for discussing alternative teaching behaviors as well as alternative curriculum designs. As teachers learn Logo, I have the opportunity to do the following:

1) **To model an alternative role for a teacher, as coach and facilitator.** As teachers program in Logo, they necessarily create problem situations for which I do not immediately have the solution. When these situations arise, I talk about my role, not as the all-knowing expert, but as the fellow traveler. I talk about the difficulty of knowing when to offer help and when to step back and encourage watchfully. I talk about my ability to model strategies rather than provide answers. I require that teachers try to teach Logo to someone else so that they can try on these teacher behaviors and see how they feel.
2) **To offer an alternative to "steeplechase mathematics".** I invite teachers to think about their curriculum as an area of exploration rather than a set of rigidly

placed hurdles, such as might exist on a steeplechase course. Logo provides a place where they can see such an area of exploration and understand its potential value in their classrooms.

Teachers Becoming Computer Literate

My beginning course in Logo is frequently the first computer course a teacher takes. Although computers have been around for a decade, I still meet teachers who have never worked with one before. In addition to the dialogue we establish about teaching and learning in my Logo classes, programming in Logo helps teachers to understand the capabilities and limitations of computers.

Conclusion

Teachers are not learning Logo in order to draw pretty pictures, nor to teach their students how to draw pretty pictures. The pictures are appealing rewards for the sometimes arduous and challenging process of solving problems. If producing elegant products were a valuable goal, we would offer courses and do elaborate research about MacPaint and Print Shop. The experience of learning Logo, however, does indeed raise questions about educational outcomes and reforms.

It is my goal as an educator to help teachers to think critically about what they do in their classrooms and why they do it. The introduction of computers, with their potential to change the ways school work and the ways social interactions are organized, provides an impetus to do such thinking. Logo particularly contributes to an atmosphere of discovery and exploration in which the very unfamiliarity of the computer language invites teachers to question the comfortable habits of their teaching repertoires. I teach a variety of courses in which the roles of computers in education are explored, but it is in my Logo class that teachers truly gain insight into the processes of teaching and learning.

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A Required Problem Solving Course for Undergraduate Preservice Teachers

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Abstract

The University of Wisconsin-Superior has developed an undergraduate two and a half semester credit hour course which is required of all preservice elementary teacher preparation students. This paper outlines in detail the curriculum used in the course, the teaching strategies used, and the student outcomes achieved.

The purpose of this course is threefold. The primary goal is to teach problem solving within the dynamic interactive environment offered by computers. In addition, students become familiar with the mechanics of computer use and with the microcomputer as an interactive tool. Also, students experience using the *LogoWriter* environment for their own mathematical problem solving and teaching mathematics lessons to elementary school aged children using *LogoWriter* as the tool. In the process of completing course requirements, students develop interactive *LogoWriter* programs which can later be used with children, parents, and others within actual school settings.

Preservice teachers complete their teacher education program able to use technology within the school setting, use *LogoWriter* as a mathematics environment, and teach problem solving using the interactive environment of the microcomputer.

Introduction

The University of Wisconsin-Superior has developed an undergraduate two and a half semester hour course required of all preservice elementary teacher preparation students. This paper outlines in detail the curriculum used in the course, the teaching strategies used, and the student outcomes achieved. In addition, information about student evaluation and assessment and alternate forms of the course are included.

The purpose of this course is threefold. The primary goal is to teach problem solving within the dynamic interactive environment offered by microcomputers. In addition, students become familiar with the mechanics of computer use and with the microcomputer as an interactive tool. Also, students gain experience in using the *LogoWriter* environment for mathematical problem solving and experience in teaching mathematics lessons to elementary school aged children using *LogoWriter* as the tool. Finally, in the process of completing course requirements, students develop interactive *LogoWriter* programs which can later be used with children, parents, and others within actual school settings.

Curriculum

The course is taught within the traditional higher education framework of Monday, Wednesday lecture and Friday lab. Students attend two one hour lectures each week and participate in a one hour large group lab.

The lecture meetings are held within a typical university level classroom, not specifically equipped with high technology. However, there is a large group viewing monitor available which is wheeled into the room for each lecture. The monitor is interfaced to either an Apple computer or an MS-DOS machine, whichever is available, making in-class demonstrations possible. Lecture content includes an explanation of the topic for the day, followed by a demonstration run of one or more logo procedures. These demonstration procedures are examined closely and discussed indepth by the instructor and class together. The procedure(s) is executed several times to provide motivation for the topic under investigation. Finally, the instructor develops a small sample procedure(s) in class with the students in order that they may profit from the ensuing process of debugging, problem solving, and solution analysis.

The course begins with an exercise in which students develop a page/picture from the command center, save the picture to disk, and, finally, demonstrate (show) their creation to large group in a lab setting. The completion of this exercise insures that each student has a working copy of *LogoWriter*, can use basic logo commands effectively, save a page to disk, and consistently recall a page from disk. Since each student demonstrates these hands-on skills separately within the large group lab, the instructor is ensured that students have the necessary skills to successfully proceed.

The course continues with lectures and programming assignments on procedure writing, recursion, top-down and bottom-up problem solving, local and global variables, variable manipulation, procedure inputs, logo objects, list processing, commands and reporters, and the output instruction. The *LogoWriter* capabilities of word processing, music, multiple turtle use with animation, and random number generation and use are additional topics included in the course that seem to be of special interest to students. There are nine programming assignments due at approximately two week intervals.

In addition, students are required to plan and teach five beginning Logo lessons to children enrolled in local schools. Generally, teacher preparation students work and plan in groups of three or four and teach three or four groups of elementary school children on the same days, typically scheduled near the end of the academic term. This teaming helps with transportation to and from the university and provides each preservice teacher education student with a level of peer support which they seem to value highly.

Finally, each student is required to complete a final and summative Logo project. These projects are intended to provide the opportunity to tie together into one effort the concepts and skills that students have learned and to provide the opportunity to create something that has potential for practical application. Students are encouraged to share these projects with each other and to collaborate on the planning and production of their project. Students often plan in such a way as to divide a larger project into two or three parts, each producing a part and sharing their part with the others. This encourages the development of complex projects that might otherwise be impossible and stimulates group interdependence.

Teaching Strategies

The teaching of each concept is divided into three definite and distinct parts. First, the instructor explains the new concept, the necessary *LogoWriter* instructions, and any necessary *LogoWriter* commands for implementing the concepts. Second, the instructor demonstrates the concepts implemented within a series of procedures which have been entered, tested, and saved prior to the class. As the class watches, thinks, and poses questions, the instructor demonstrates the procedures and talks the class through the procedures. Often, execution is traced using chalk and chalkboard. These sample procedures provide working examples of the concept and motivation for thinking, which often becomes "thinking about thinking" as originally defined by Papert. Finally, the class suggests a task to implement using the new concept, and the instructor and the class together develop a new set of procedures to implement this new task.

It is interesting to note that this format provides the opportunity to demonstrate actual debugging in progress and to orally demonstrate the problem solving thinking necessary. Often, these three distinct lesson parts take two to three lecture sessions to complete. Since lectures are fifty minutes each, several class lecture sessions are necessary to fully develop one idea. Thus, it is necessary to schedule programming assignments so they are due at two-week intervals.

During the first week of class, students commit to completing programming projects in groups of two or three by indicating their names and a fantasy name for their group on a planning sheet located near the instructor's office door. The primary purpose of these student working groups is to provide help and support for group members, along with debugging help and assistance. Student work sessions are informally but regularly monitored to provide motivation for working in groups. Although formal cooperative groups are not in place, these study/work teams seem to exhibit some cooperative group characteristics. Study groups often sit together during Monday/Wednesday lecture, and "show and tell" programming assignments together during the Friday lab. It is important to note that each student is required to complete each assignment, and that groups may not submit a completed group assignment. Each assignment must be in some way different from the others, but may contain procedures developed by someone else. All borrowed procedures must include a statement giving credit to the original developer.

Additional Information

Another Format. The course is also available in the independent study format. The course outline and materials are the same as those provided in the on-campus version, however independent study students are encouraged to find a mentor who is willing to provide assistance with initial hardware and software problems. Students report that a mentor is very necessary when beginning the course, but the need for a mentor seems to decrease in importance once the student has progressed beyond the initial hardware and software orientation stage. Students report that the mentor, at least in the initial stage, is a necessity.

Computer Access. For on-campus students, it is worth noting that a microcomputer lab is available and staffed by Logo knowledgeable student-assistants for a total of 80 hours a week. Each staff person is knowledgeable about hardware and software and often serves as a consultant when logo students need specific help.

Course Materials. Since the university purchased a home use license from Logo Computer Systems incorporated, each student is provided a copy of the software. The text used is "Introduction to Programming in Logo Using *LogoWriter*" by Sharon Burrowes Yoder. In addition, all students are expected to purchase and read "Mindstorms: Children, Computers, and Powerful Ideas." Additional materials are provided periodically by the instructor.

Grading. At the beginning of the term, students are given a lesson feedback sheet for each of the required assignments. The appropriate feedback page is attached to the front of each submitted assignment. On the feedback sheet, the requirements for the assignment are listed. Completed lessons receive points for successfully fulfilling each of the requirements, and the total earned points for the assignment are recorded for each assignment for each student. Grading is essentially binary; The assignment contains the requirement or it does not contain the requirement.

Student Outcomes

Students complete the course with extensive experience in problem solving within the dynamic interactive environment offered by computers. Students become familiar with the mechanics of computer use and also with the microcomputer as an interactive tool. In addition, students experience using the *LogoWriter* environment for their own mathematical problem solving and in teaching mathematics lessons to elementary school aged children using *LogoWriter* as the tool. In the process of completing course requirements, students develop interactive *LogoWriter* programs which can later be used with children, parents, and others within actual school settings.

Preservice elementary teachers complete their undergraduate teacher education program able to use technology within the school setting, use *LogoWriter* as a mathematics environment, and teach problem solving using the interactive environment of the microcomputer.

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Technology Experience for Teacher Education: Solutions and Questions

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Abstract

The process of training both pre- and inservice teachers to use technology appropriately in the classroom at all levels as implemented at the University of Northern Colorado is described. Two undergraduate and one graduate educational technology courses are discussed. These courses provide an introduction to the technologies and through the use of modeling and role-playing encourage the students to develop and test creative uses of technology to aid the learning process.

The University of Northern Colorado (UNC) is the primary teacher education institution in Colorado. It is an innovative, progressive institution that enjoys a campus-wide commitment to teacher education. A large percentage of the 11,000 students are involved in education both at the graduate and undergraduate levels.

The Educational Technology program, which offers M.A. and Ph.D. degrees, as well as library/media certification, is integrally involved with teacher education at UNC. Two undergraduate courses and a full range of graduate courses are offered through the educational technology program. They range from courses in computer based instruction to courses in instructional design theory. This paper focuses on three of the courses in which professional teacher education students are likely to enroll. It describes the underlying philosophy of these courses, as well as the scope and sequencing of the individual courses. It also describes the progression of skills that students are likely to acquire if they choose to take all three courses. Issues and concerns about the limited impact that these courses are likely to have on the teacher practice are raised.

The three courses are ET 401, Classroom Educational Technology; ET 425, Computer Applications in Education; and ET 503, Computers in Education. ET 401 is required of all professional teacher education (PTE) students at UNC. It is a general course in educational technology that explores various technologies, including video and computer technology. ET 425 is an elective course that deals with a wide variety of computer issues in the K-12 environment. ET 503 focuses on the integration of computers in the classroom.

Philosophy

The basis for these courses is the idea that no technology becomes effective in education until it is as natural to use as a pencil or piece of chalk. Further, technology use is effective only when appropriate selection of technological tools is made, matching the tools with the situation for their use. If only a few tools existed, paper and pencil or chalk and slate, the problem of training teachers to select and use technology appropriately would be simple. Unfortunately, the array of possible tools and the wide variety of conditions (both student and environment) to be met in education today makes training difficult at best.

Simply lecturing and demonstrating how a technology can be used is not sufficient. Therefore, the philosophy guiding the design and development of these courses is experiential learning (Dewey, 1938). The goal is for teachers to have the skills to analyze situations, identify needs, and match those with appropriate technologies to meet the performance goals for their students. To accomplish this, teacher training must begin with concrete experiences that are relevant to the teachers. Teachers are provided with opportunities to reflect and extend those experiences, learning new skills, which are in turn related back to the experience those teachers already have or may have in the future.

In all three courses, the philosophy has lead to a design that places the learners (teachers) in a setting where they are being taught how technology is used through appropriate use of technology. The course instructors model appropriate uses of technology. Teachers are asked to participate in the use of the technology, as if they were their own students. In addition, teachers are asked to develop ways to use those technologies that fit their situations. In other words, appropriate use of technology is modeled and teachers are asked to follow those models in creating their own uses of technology.

The content of the courses is organized in a progressive manner, Table 1. The content is structured to provide concrete, knowledge level experiences first. As experience is gained, the courses begin to focus on applications of the technology to teaching situations. Finally, the focus shifts to implications and the exploration of how technology can be applied effectively in situations not yet experienced directly.

ET 401, Classroom Educational Technology

ET 401 is a general course in educational technology that explores the various technologies. These technologies include video and computer technology, various computer applications, as well as telecommunications, film and video use, video production, projected and non-projected media including equipment operation, bulletin boards, and chalk boards.

The foundation upon which ET 401 is built encompasses the following three goals. First, teachers must be proficient, critical users of current educational technologies; Second, teachers need a broad education in order to determine the applications of changes and innovations in technology from more than one perspective; and finally, teachers must be competent designers of instructional systems that will enable them to assist their students to become critical thinkers (Bitter & Yohe, 1989).

In addition to these general goals, Heinich, Molenda, & Russell (1989) provide specific guidelines about the teaching/learning process that should also be developed in PTE courses. In accord with these guidelines, ET 401 instructors model a variety of innovative teaching strategies, making use of the appropriate technology, and engage students in meaningful, relevant hands-on experiences with technology within ET 401.

ET 401 is a project oriented class that stresses student involvement with the technology. However, given the rapid changes in technology, the ET faculty recognizes that teaching students which commands to enter to operate a computer program or which buttons to push on a machine should not be the focus of the course. Instead, the focus of the undergraduate program should be on assuring that the students have a basic handle on the technology. These students must be prepared to recognize the significance of technology and realize that it is a part of everyday life, so they can update skills throughout their careers (Bruder, 1989). The preservice program designed around this focus can provide future educators with the amount of instruction required to successfully integrate and apply technology in the classroom (Bitter & Yohe, 1989).

In order to work toward this end, the projects assigned in ET 401 are designed to foster success so that students will develop positive attitudes about technology in the hopes that they will continue to embrace the technological innovations. The major projects focus on integrating computer skills with other technologies in order to reach instructional goals. For example, students are asked to produce an instructional video that incorporates the use of computer graphics or text. Instruction is provided on the use of the camera, filming angles, and in-camera editing techniques. The purpose of this video project is to develop an awareness of the use of video technologies as an addition to traditional class assignments. For example, students in ET 401 design an instructional sequence, word process it, then produce a video of their instructional sequence as well.

Practical, concrete technological experiences for teacher education students is a positive step toward preparing teachers in the use and integration of technology in the classroom. However, these experiences are not enough, and it is only after the students apply this knowledge that the level of effective use is increased.

ET 425, Computer Applications in Education

ET 425 presents an overview of educational computing through simulations, lectures, and discussions. Subjects addressed include hardware, software, lesson integration, and issues, such as equity, gender, and ethics.

The infrastructure of ET 425 intertwines several assumptions. First, teachers need the skills necessary to creatively integrate computer technology into their teaching. Secondly, teachers in our information-rich age

	ET 401	ET 425	ET 503
Video technology	X		
Non-computer based educational media	X		
Basic awareness of computer technology in education	X		
Knowledge of computer terminology	X	X	
Basic computer applications--word processing, spreadsheet, database	X	O	O
Exploring educational software/courseware	X	O	√
Other applications--graphics, utilities	X	O	√
Running hypermedia programs		O	
Issues in computer networking		O	
Improving personal productivity		O	
Programming		O	√
Evaluating educational software/courseware		O	√
Understanding the role of CBI		O	√
Integrating CAI software into curricular areas		O	√
Integrating applications software into curricular areas		O	√
How to use computers to teach problem solving skills		O	√
Designing lessons that use computer technology		O	√
Understanding the impact of computers on society		O	√
Knowledge of appropriate hardware/software to meet curricular needs		O	√
Authoring hypermedia programs			√
Issues: The use of technology and political constraints, classroom organization, coordination with course objectives			√
Developing a systematic evaluation scheme for software/hardware			√
Synthesizing classroom management, physical environment, available resources, learning objectives, etc. to design instruction			√

Key: X: Concrete Experience O: Application √: Implication

Table 1.

need to shift their role focus from that of being solely disseminators of knowledge to that of being facilitators of learning (McPortland, 1990 Steen, 1989).

The course focuses on providing the students with opportunities to experience the effective use of technology through instruction in its appropriate use. In the course, the instructor models innovative, equitable uses of technology in specific grade-level content areas. Students are asked to participate in the classroom simulations from the perspective of the grade-level learners. Additionally, students are asked to develop methods in technology uses that fit their unique professional preparations. In this way, creative use of technology is modeled and students are asked to follow those models in originating their own technological employment.

One such facilitated activity is a geography lesson simulation. In a Macintosh computer lab, the students are divided into groups of three. Each group works at one computer. Each member of the group is assigned a different task: referencing, recording, or entering data. The reference person is responsible for finding facts up in the almanac, the recorder keeps track of the data on paper and the data entry person operates the keyboard. At 10 minute intervals the jobs were rotated. A handout, such as might actually be used, is given to each student. The handout explains the duties of each group member and the assignment. The assignment is to play the computer game *Where in the World is Carmen Sandiego?*. The team is to record on paper at least 8 countries visited as detectives in the game and use the World Almanac to discover 10 specific facts about each country (such as the continent, language, major geographic land marks, the major industries, etc.). The group also plots and labels all the cities visited on a world map. The work takes about an hour.

Following completion of the game playing, each group creates a database using the collected country data, with a record for each country and fields within the record corresponding to each category of discovered facts. The database is used to sort two countries with two similar features from the whole list . The sorted list is imported into a word processor where the students as a group describe the similarities and differences of the two countries and diagram the countries' flags.

After the activity, each group wrote a reaction paper describing their perceptions as learners participating in the lesson and ideas on how the learned skills will benefit them as students and future professionals. The participants felt that the lesson was motivating and had application to many content areas. The end result of the geography lesson was knowledge as to how an innovative use of a laboratory setting can support a curricular area and motivate students. In addition, individual students felt that the skills learned could be transferred to many settings.

ET 503, Computers in Education

In many ways, ET 503 is very similar to ET 425. Many of the same topics are covered, and there is some similarity in both the instructor's approach and the assigned projects. The shift toward implications can be made in this course because of the graduate level. The vast majority of students either are teaching or have taught in some setting, bringing a wealth of practical experience to the course, which cannot be assumed in the undergraduate courses. Since the students already have experience teaching, less time is spent demonstrating and simulating teaching situations, allowing for more class time devoted to reflective and speculative discussions of the implications of the experiences provided.

This does not mean that less modeling and simulation of educational situations is included. Instead, less time is spent on the mechanics of hardware and software operation. Indeed modeling is of critical importance if the implications of an approach are to be discovered. For example, one exercise conducted about half way through the course is a language arts lesson simulation. The lesson occurs in a computer lab. Students are divided into groups of three to four and provided with an introduction to the lesson. The introduction consists of a short handout, such as they might actually use, that reminds them of the characteristics of short fiction that had been covered on previous days (in an imaginary language arts class). The assignment is for each member of each group to work independently to develop a character for a science fiction story. The description had to include the planet of origin, a description of the character's appearance and personality, and a problem the character has. Students were given about half an hour to develop the character and word process the information so that everyone in the group would have a copy. Once the characters were developed, the groups were to come together and, sitting at one computer, write a short story that used all of their characters and solved each character's problem by the end of the story. One hour was allowed to write the story.

Following completion of the story, each group had to write a reaction paper describing their feelings as learners participating in this lesson and their reactions as teachers to this approach to instruction. The reaction papers served as the basis for class discussion of the positive aspects of the exercise—collaboration, problem solving, creativity, possible extensions that would lead to improved writing skills in all subject areas—and negative aspects of the exercise. The only consistent negative aspect is concern over classroom management and the freedom allowed in the lesson the teachers participated in. The solution to the management concern was to identify ways of imposing additional structure on the exercise, as appropriate to the grade level and subject matter. All of the students participating in the lesson felt that it was motivating for students and had application/implication in a wide variety of settings. The end result of the language arts lesson is knowledge about how a laboratory setting can be used creatively and appropriately to support a curricular area and motivate students. Further, individual teachers could identify how such an approach would need to be modified to fit other situations. It is these results that are the target of ET 503.

Spiral Curriculum

In addition to the knowledge to implication continuum represented by the content of these three courses, the design embodies to a great extent the ideas of Bruner's (1960, 1966) spiral curriculum. The important concepts are repeated both within each course and across the courses at successively greater depth of complexity. For example, evaluating and selecting effective courseware requires knowledge of content, characteristics of media, instructional features, and methods for evaluation. Without experience with a wide variety of courseware, the teacher does not have a basis for intuitively selecting materials. Furthermore, intuitive selection is often not the best approach.

To overcome the limited experience available to preservice teachers, the topic of courseware selection in ET 401 is handled in terms of providing experience with a limited selection of courseware. In ET 425, the topic expands the experience with courseware and begins to formalize the characteristics of effective courseware. In this course, the concepts and skills are moved from simple experience to consideration of some formal approaches to selection. Both undergraduate courses serve to begin the process of gaining an experience base from which to judge the materials for selection. However, the amount of experience is insufficient to develop an intuition. Even the addition of experience in ET 503 would not provide a basis for decision making. However, it is possible to provide training in a formal structure for evaluation and selection of courseware that builds on limited experience and generalizes to a flexible and powerful technique. ET 503 focuses on the development and implementation of a formal evaluation and selection tool that can be adapted to any situation, completing the spiral.

Conclusion

Although much thought has been devoted to the design and development of these educational technology courses, they have only limited impact on the teaching practice of participants. To be effective, technology must be integrated into all courses, campus wide. The Educational Technology faculty at UNC is committed to a leadership role in this effort. To have a substantial impact, the following challenges must be met.

- Many faculty have only limited awareness both of technological resources available and the capabilities of those resources.
- Release time necessary to learn new technologies is not available.
- There is no reward system for faculty who attempt innovative uses of technology.
- There is limited technical support for those faculty using technology.
- Inequities exist among programs and colleges in terms of availability of appropriate technology to meet instructional needs.
- Even when resources are available, many faculty have limited knowledge of how to effectively integrate it into their courses.

The Educational Technology faculty hope that the courses discussed in this paper will serve as models upon which other courses can be redesigned to effectively implement technology. It is important for those involved in educational technology to share their expertise with others who are willing to adopt innovative teaching methodologies. In this way, a critical mass of faculty can be developed, who can then serve as change agents to influence others across the university, including the thousands of preservice and inservice teachers at UNC.

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Teaching Technology in a Field-Based Undergraduate Education Program

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Abstract

In Fall 1990, Hunter College implemented QUEST (Quality Urban Elementary School Teachers), a new field-based undergraduate teacher preparation program, in which most education courses are taught in cooperating, inner-city public schools. Teaching educational technology in such a program poses unique challenges and offers opportunities to forge new relationships between the College and the public schools. The purpose of this article is to share the experiences of the faculty in the QUEST program who teach educational technology and who are providing assistance to the public schools. It describes an interesting triad of college faculty, school personnel, and undergraduates working together to solve technology-related problems that are common in many inner-city public schools.

Introduction

In Fall 1989, Hunter College implemented a new undergraduate program in elementary education called Quality Urban Elementary School Teachers (QUEST). It is a field-based program in which most education courses are taken at cooperating public schools, located in inner-city, mostly minority communities. The major focus of QUEST is to prepare teachers for the urban schools by giving them as much exposure and experience as possible in real-life settings. A one semester course in educational technology is also a requirement of the program. How this course is evolving, especially in relation to the field setting, may be of interest to educators around the country who might be considering a similar approach.

The purpose of this article is to share the experiences of the faculty in the QUEST program who teach educational technology. This approach has required them to extend themselves and to lend technical assistance to the public schools that are struggling to utilize technology in their own educational programs. The article describes a most interesting triad of college faculty, undergraduates, and school personnel working together to solve educational technology problems for the benefit of all, but especially for the children in the public schools.

Background on Field-Based Education, the Setting, and Technology

The task of educating children in urban environments has been one of the major challenges in our country for the past twenty years. The familiar problems of crime, drugs, teenage pregnancy, and changing family structures have become commonplace and are becoming more severe. The task of preparing young adults to teach in the urban public school systems has become almost as much a challenge as the problems themselves. Many of the traditional approaches were failing and the need for innovation led Hunter College to experiment with field-based teacher education programs. The QUEST program is the formalization of experimentation that originally began in the 1970s with a grant-funded program at Hunter called TTT (Training Tomorrow's Teachers). It is not the purpose here to evaluate the benefits of field-based teacher education, however readers may wish to refer to Thiessen (1989), Hollinsworth (1988), Booker and Riedl (1987), or Nicklas (1982) for further descriptions and analyses on this topic. Suffice it to say that in Hunter College's Division of Programs in Education, many faculty members are committed to the concept and have seen the importance and effectiveness of providing field experiences to undergraduates aspiring to be teachers. It has been particularly effective in helping undergraduates to finalize their decisions to become teachers by giving them a "close-up" look at what it means to be teachers in the inner city.

While there are almost one thousand public schools throughout New York City representing many diverse communities, most of the cooperating schools in the QUEST program are located in East Harlem. This is a typical inner-city community with many urban problems, but also one that is proud and has a long, rich history of being the new home for recent immigrants to New York City. Over the past two hundred years, it has been home to Dutch, German, Irish, and Italian immigrants. Today, it is a multi-cultural community with a large Latino population. While it is vulnerable to big city ills, and evidence of crime, poverty, and drugs is readily apparent, it also has many hard-working and dedicated families who are trying to do what is best for their children. The schools are a reflection of the community, so that while administrators must make additional commitments in terms of social programs, family assistance, and physical security, it is also common to see volunteer parents and grandparents in the hallways helping teachers, students and administrators.

The decision to require an educational technology course in the QUEST program was made in 1988 in recognition of the importance of utilizing new technologies, namely computer and video, in teaching and learning. It also was made in recognition of the importance of preparing students to function in a large metropolitan area whose economy is most dependent on services such as finance, banking, management, and communications which make extensive use of these technologies. The content for the course was based in part on a survey of 136 public schools in the New York City area, see Picciano (1991), and Picciano and Kinsler (1991). Among other things, this survey indicated that while the public schools were making extensive investments in technology, they were also having many problems in implementing effective programs because of a lack of teachers trained to use technology, a lack of sufficient support services, and other budgetary, technical and curricular problems. These issues are not unique to New York City but are common in school systems across the country. Several researchers (O'Neill, 1990, and Sheingold & Hadley, 1990) have observed that many school districts are having difficulties implementing effective computer education programs. Some of them have also concluded that urban schools face problems in implementing technology that their counterparts in suburban and rural communities do not (Apple, 1987; Sheingold, Martin, & Endreweit, 1987; Simmons, 1987). The problems were serious enough that the Hunter College faculty decided that educational technology would be the only required course in the QUEST education sequence that would be taught at the College and not in the field.

The course itself is a basic survey course which exposes students to two major technologies, namely computer and video. It has a major laboratory component that requires students to use and evaluate instructional computer materials such as simulations, *Logowriter*, problem-solving and tool software packages. It introduces students to data communications, databases, and educational network services. It also provides a review of video technology including videodisc, multimedia, and interactive video. In keeping with the QUEST philosophy, students are expected to develop lesson plans and to practice teaching using appropriate technology in the field. Unfortunately, it became readily apparent that this would be problematic because the cooperating schools were struggling to provide and support technology in their own programs, let alone for the College's undergraduates. So while the College had appropriate equipment, software, and facilities for teaching technology, because of the lack of same in the public schools, it became difficult for students to practice in the field what they were learning in the college classroom.

A Case Study

In February 1991, during the second meeting of the educational technology course and after having heard the standard lecture on the effectiveness and potential of technology in education, one undergraduate asked why the elementary school in which she was assigned did not provide any computer instruction. This was a very good question and caused some concern to the instructor. It was his impression that computers were available and being used in that particular school. Furthermore, he had planned to give the class several assignments that would involve developing lessons to be taught on-site utilizing the facilities at that cooperating public school.

The following week the instructor visited with the principal of the school and discovered that, indeed, there were no facilities at the school, and that the computer room (Room 212) had been closed for more than a year. The former (and only) computer teacher had left teaching, a problem common in urban areas where there are better paying job opportunities in technical service industries. The principal had been trying to hire a replacement, but because of budget cuts as well as a shortage of good computer teachers, she had been unable to fill the position. Finally and reluctantly she had decided to close the room. One of her art teachers, however, was taking courses in computer education, and she hoped he might be ready in the coming year to provide some computer courses. Some additional technical support would be required, and she asked the instructor if he knew anyone who might be willing to work part-time at the school to provide technical assistance.

Following their meeting, it occurred to the instructor that he along with his undergraduate class might be able to provide some assistance to the school. He shared his thoughts with the educational technology class, and most of the students were willing to volunteer some extra time in their already busy schedules to lend assistance in reopening the computer room. He met again with the principal who indicated that she would be most grateful for anything the class could do and promised her full cooperation. For the next two months, the instructor and some of the undergraduates spent time each week engaged in various activities required to reopen the computer room. These included taking a hardware inventory, setting up and testing equipment, organizing the software cabinet, and even decorating the room. During the same period, the instructor also developed a mentoring relationship with the art teacher who was taking computer courses. He proved helpful with many of their activities such as locating software, supervising access to the room, providing supplies, and getting the lights fixed.

By April 1991, the computer room was reopened on a limited basis. It housed fifteen Apple II microcomputers and a small but appropriate software library that included multiple copies of some of the easier to use simulation, desktop publishing, and Logowriter software programs. At the request of the principal, the school district began to provide weekly staff development sessions on the use of computers in elementary school teaching. By early May, several teachers at the school were taking groups of students to the computer room. For the vast majority of these children, it was their only exposure to computers for the year.

In Fall 1991, the principal scheduled seventeen class periods for Room 212, and the majority of students in the school now receive some computer instruction each week. The art teacher has continued his computer studies and most of his program consists of teaching computer courses. While the school has a long way to go in terms of being on the "cutting-edge" of educational technology, it has made major progress in establishing a basic computer education program.

For the QUEST undergraduates, in addition to being able to use the room to conduct several "hands-on" lessons with children at the schools, it became an invaluable lesson in preparation for teaching. It was a clear demonstration to them that they can and should be involved in finding solutions to problems in the schools.

Discussion

The reopening of Room 212 was a unique experience that was completely unplanned but was made possible by the field-based nature of the QUEST program. All involved—the undergraduates, the public school teachers, administrators and students, and even the College's education faculty—have benefitted from it as have the overall instructional programs at the public school and at the College.

The undergraduate who made an "off the cuff" comment in class about a problem that existed in the school where she was assigned, opened a door leading to an invaluable experience for herself and her classmates. They participated in identifying a problem and implementing the solution. They experienced a little success and developed a sense that the "system" can work. At the very least, they have seen first-hand that real-life problems can be corrected and situations changed if one takes the initiative, asks the right questions, and is willing to do a little extra work. Hopefully, they will remember and repeat this experience when facing similar situations as teachers in an urban public school.

For the public school, its administrators and teachers, their instructional program has been enhanced to the point where some basic computer instruction is provided. Despite budget realities and other support problems within their district, their computer program is now considered a viable one in which several hundred elementary school children are being introduced to technology who otherwise might not have. They are happy to be doing something; they look forward to doing more.

The College and the faculty in its teacher education program have also benefitted. While this experience has given them a more realistic view of the public schools, it has also provided them with a vehicle to become more involved. Since the experience in Room 212, faculty are now lending assistance to the computer education programs in two other schools in the same local community school district. While the settings, personnel, and problems are different, the overall situations are the same. The schools are in need of people with some expertise, particularly in computer and video technology, to help them in developing their instructional programs and services. The faculty are now more willing to provide part of this assistance.

One faculty member has recently received a grant from the New York State Education Department to upgrade the teaching of science in the elementary schools in the district. A major component of the grant is a training module on the uses of computer and video technologies in teaching science while another part of this grant involves acquiring videodisc equipment and software for use in the district. A college-school partnership grant is also under consideration by the New York State Department of Education that will help school administrators in this district to develop and foster academic leadership. One of the areas that district representatives requested be part of the leadership training was the use of educational technology. They specifically cited the work done in the public school that was described above. If this grant is approved, it will provide released time from teaching for faculty to engage more fully in technology assistance activities.

Conclusion

In conclusion, the formalization of a field-based program has added a new dimension to the teacher education program at Hunter College. This approach is not viewed as a panacea for teacher education in general. However, it does appear to be working in this specific urban setting and is proving to be more effective than an essentially college-based program. The above case study is indicative of the additional benefits that can result from field-based education. The need for technical assistance was discovered almost accidentally as a result of the field-based nature of the program. The response to this need by the college faculty and undergraduates then became the impetus for a whole series of direct and indirect activities involving partnerships that continue to benefit all involved.

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Efforts to Promote Technology at a Teacher Education Institution

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Abstract

This paper describes activities initiated by five faculty and professional staff members at a state college of education to increase the knowledge and use of technology among the college's faculty, professional staff, and students. The group, rather than administrative mandate, has formed the leaven through which the use of technology among the targeted groups has grown. The paper includes information on the college, evolution of the role of the group within the college structure, specific activities implemented, and suggestions for institutions facing similar challenges.

"Preservice teachers do not know enough about using technology in the classroom." "We have computers in my classroom, but I don't know what to do with them." "Education faculty members do not model the use of technology in their classes." Such comments were very common around our teacher education institution. While several faculty members used technology very effectively, many did not use it at all. This paper describes a grass-root effort that began during the summer of 1990 when an interested group of five faculty and staff members at Harris-Stowe State College began to meet to plan ways to increase the use of technology by faculty and students. We believe our approach is unique in that this group, as opposed to administrative mandates, has formed the leaven through which the use of technology among faculty at the college has grown.

Background

Harris-Stowe State College, located in St. Louis, Missouri, traces its origins to 1857 when it became the first public teacher education institution west of the Mississippi. Today it is a member of the Missouri system of public higher education with a four fold mission: preparation of teachers at the preschool, primary, and middle school levels; inservice training programs for teachers; preparation of urban education specialists; and community service. The college has an enrollment of approximately 2,000 students. This includes undergraduates and inservice teachers. There are 37 full-time faculty members and 15 professional staff members. The college is a historically black college and receives funding from a Title III-B grant.

Resources

The college has an IBM PS2 model 50Z and model 55 classroom lab, an Apple IIGS classroom and multimedia lab, an Apple IIe/IBM XT classroom lab, a drop-in lab containing a variety of these machines, and four Macintoshes, located in the Instructional Media Lab. In addition, the college's resources include CD-ROM players equipped for multimedia, both test score scanners and flat bed scanners equipped with graphic and Optical Character

Reader (OCR) software, a satellite down link, large software library, laserdisc players, and projection devices.

Process

After informally surveying the use of technology by faculty, the group approached the vice-president for academic affairs with a request for time during the faculty inservice workshop scheduled for the beginning of the Fall 1990 semester. Once permission was received, a demonstration on a variety of ways technology was currently being used on campus was prepared. The group requested and received permission for a brief technology demonstration at subsequent monthly faculty meetings. Members also surveyed faculty members to determine which areas of technology were of greatest interest.

Initially, members of the group volunteered their time for the activities and demonstrations. Every faculty and professional staff member is expected to serve on at least one of the college's standing committees. During Fall 1990, the administration recognized the group as a standing committee under the college's committee structure. In that first year, members continued to serve on a second standing committee to which each had been assigned prior to the official recognition of the Education and Technology Committee, but for the academic year 1991-92, members were assigned only to the Education and Technology Committee. Once the committee was recognized as a standing committee by the administration, membership on the committee was expanded and committee goals were prepared. Major goals formulated were

1. To increase faculty, staff, and student understanding and use of technology and its application to teaching and day-to-day operations of the College.
2. To provide inservice technology demonstrations at regularly scheduled faculty meetings.
3. To schedule regular "extended" technology demonstrations for faculty, staff, and students.
4. To establish a centralized database for all technological instructional resources, including hardware and software.
5. To increase faculty awareness of the benefits of technology in the area of research.
6. To create a faculty-staff technological resource brochure.
7. To offer technology related mini courses for faculty and staff during the first five days of each semester.
8. To work with the teacher education and urban education faculty to continue to strive for contemporary literacy requirements for HSSC graduates.
9. To plan and implement a faculty technology resource room.
10. To achieve all of the above listed goals and to become obsolete.

The committee has no direct funding source. The College's Title III-B grant has provided some assistance, particularly through the services of the Title III-B funded campus Academic Computing Facilitator. Limited availability of financial resources has resulted in members relying more on in-house strengths and local resources, being more creative and, on occasion, scaling down projects. It has not resulted in a lack of more ambitious plans by the committee members should funds become available.

Committee Activities

The committee has initiated several activities since its formation. These include a variety of faculty/staff workshops, technology presentations for student teachers, preparation of an instructional technologies resource list (hardware, software, and personnel), assistance with presentations involving technology in courses, and creative scheduling of a special course for faculty and staff. In addition, members are working on an individual basis with interested faculty members to encourage the increased use of technology in individual classes. This year a class on *PageMaker* is being offered to faculty and staff in response to a request from faculty and staff. The class meets across both semesters and has been scheduled to avoid conflict with particularly busy times during the semester. It is being taught by the Title III-B funded Academic Computing Facilitator on campus. Faculty and staff have been exposed to the area of teleconferencing and telecommunications through a recently completed satellite link through the local community college's facilities. The system was demonstrated at a faculty meeting, and in August 1991, the college sponsored its first teleconference, "Classroom Assessment". The target audience was the current class of student teachers. Two committee members planned and presented a session on new technologies in education for a Title III-B funded seminar on "New Visions in Urban Education" during summer 1991.

Progress Assessment

Committee members feel that they have made some concrete steps toward achieving many of their goals. As a result of the committee's activities, the faculty and staff have been exposed to a variety of technologies. The *PageMaker* class filled immediately. Several interested faculty and staff members had to be turned away. There have been requests for another course under this same format for next year. Workshops have enabled non-users to get some hands-on experience, while those who were already users have been introduced to new technologies. Many have also been willing to share their expertise at presentations and workshops. Because of encouragement from committee members, computers are now being used in courses, such as art, music and several methods courses, where they had not previously been used. Harris-Stowe students are now given the opportunity in several classes to observe and assist with students from a neighboring magnet elementary school when those students use the computer labs at the college as part of a partnership program between the college and the magnet school. A member of the Education and Technology committee has coordinated and planned these visits with the magnet school faculty since Fall 1989, but it was only through open dialog on technology that other college faculty members have become aware of availability of these visits to their students. It would be nice to be able to say that every faculty member now uses technology effectively, but we can't make that claim. Definitely more faculty members are now using it, and many directly attribute their use to activities sponsored by committee members.

Suggestions for Institutions Facing Similar Challenges

Based on its experience, what advice would the original core group give to individuals who would like to attempt similar grass-root efforts?

1. Form a nucleus of other faculty and staff members with the common interest and willingness to work on activities promoting uses of technology.
2. Seek administrative authorization and recognition for committee activities.
3. Provide two tracks of activities. Include hands-on activities in which non-users can be easily successful, and indepth hands-on activities for users.
4. Draft as many users as possible to assist with sessions for non-users or to share their expertise with other users.
5. Involve non-users in demonstrations. This provides encouragement to other non-users.
6. Keep presentations short and simple.
7. Explore outside resources, including both technical facilities and individuals.
8. Involve individuals from a variety of specializations. The original core group consisted of members from the education faculty, the biology faculty, and the computer education faculty, in addition to the director of the instructional media lab and the Title III Academic Computing Facilitator. Additional members on the current committee include members of the sociology faculty, the music faculty member, the library staff, and the director of athletics and two students.
9. Show the non-users how the machine can help them do a task that needs to be done more easily.
10. Collect and distribute articles on uses of technology in specific areas to faculty members in those areas.
11. Locate and pursue possible funding sources.

Conclusion

Harris-Stowe State College is not a large institution. This might appear to be a major factor in the ability of a group such as this to carry out its agenda. Individuals from larger institutions should not rule out the possibility of attempting similar grass-root activities at a division or school level.

Our committee is not yet ready to claim that it has achieved its final goal—to become obsolete. But we are getting closer to it. Special thanks to the other members of our original core group: Jacqueline Dillon, Jim Klingler, and Terry Werner.

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Teacher-Preparedness for the Information Age

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Abstract

The paper reports the perceptions of administrators of the member institutions of the American Association of Colleges for Teacher Education on the topic of Teacher-Preparedness for the Information Age. The importance that teacher preparation institutions attach to the topic and the changes they are making in response to the Information Age are explored.

To the surprise of almost no one, the oft-predicted Information Age has arrived. Perhaps not as swift to arrive is education's response. How well is the nation's educational system preparing its graduates to live in, work in, compete in, and thrive materially, vocationally, and personally in the new milieu?

Moreover, how well are teachers prepared to aid their students toward such goals? Indeed, how well equipped are the teachers themselves to participate in the Information Age professionally and personally?

Writers of the past two decades (Handy, "The Age of Unreason"; Dizard, "The Coming Information Age"; Toffler, "Future Shock" and "The Third Wave"; Naisbitt, "Megatrends" and "Megatrends 2000"; Marchand and Horton, "Infotrends"; Masuda, "The Information Society"; Penzias, "Ideas and Information"; Bell, "The Coming of Post-Industrial Society"; Peters, "Thriving on Chaos"; and Gilder, "Microcosm") foresaw a radically different era once the full impact of the Information Age was felt. The changes, these authorities suggested, would be as pervasive as those between a hunting society and an agrarian one, between an agricultural civilization and an industrialized one. If this "sea change" indeed happens, the Information Age will increasingly reform educational practice, no doubt in ways that even the experts are hesitant to predict. What already seems sure is that the reformation has the potential to profoundly touch all relationships among pupils, teachers, parents, administrators, taxpayers, benefactors, overseers, and others connected with the educative enterprise. It could fundamentally alter the governance and financing of education. In short, even leaving technology aside for the moment, the Information Age may change, possibly beyond recognition, every significant aspect of education.

While most of these basic changes will require the next half-century or more to fully assert themselves, they will nevertheless come to dominate the landscape of the professional careers of today's graduates. Unquestionably, the need for systematic and intensive inservice education will greatly increase, but the more immediate issue is one of laying the most complete foundation for the Information Age that can be accommodated within today's preservice programs.

How do those in charge of the schools of teacher education view these issues? Are they aware of the advent of the Information Age? Are they changing their institutions to meet the emerging needs? Are they adapting their practices rapidly enough to respond to this significant challenge?

In an effort to answer these latter questions, the author asked the leadership of member institutions of the American Association of Colleges for Teacher Education (AACTE) to respond to a "Survey of Teacher-Preparedness for the Information Age" during the spring and summer of 1990. Three issues were addressed:

- the extent to which teacher preparation institutions are aware of Information-Age implications for the teaching profession and for their students,
- the importance that the institutions attach to these implications, and
- the degree to which the institutions are changing in response to the implications.

A "Total Response"

The design of the instrument reflects the author's own agenda for education's response to the challenge. The agenda is based upon several decades of professional experience in both education and the information/communication field. The intention was to include all the elements that an institution would employ in making a "total" response to the requirements of the Information Age. These elements were stated in the cover letter and also used as section headings within the instrument. They are:

1. Using the Information-Age technologies themselves for preservice education.
2. Helping teachers-in-training become skilled in the use of such technologies in their teaching.
3. Helping teachers-in-training to function in the Information Age as individuals and citizens.
4. Helping preservice teachers become proficient at introducing their students to the Information Age.

The survey also inquired about the institution's sense of obligation to help inservice teachers and administrators with similar concerns.

The assumption is that any institution dedicated to a balanced, yet comprehensive, preparation of its graduates will wish to address all of these concerns.

Participation in the preliminary survey was quite gratifying, and the results were encouraging in respect to most of the questions. Two hundred and ninety-seven responses, representing more than forty-two per cent of the approximately 705 AACTE institutions, replied, and virtually all of those appeared to view the issues as worthy of serious study.

Survey Conclusions

Almost all schools seemed comfortable with the term "Information Age" (this term was deliberately left open-ended so as not to inhibit responses). All but nineteen respondents indicated that they and their colleagues believed that "teacher preparation must include instruction in how to deal successfully with the Information Age."

Even more encouraging, the institutions, almost without exception, reported that they were implementing changes. In fact, a number claimed to be making progress in all areas surveyed.

Specific Findings

Awareness/Leadership

Most of the responding teacher preparation institutions reported:

- a moderate to high commitment to preparing their students to function in the Information Age (Item A)
- the beginnings of changes to carry out their commitment (Item B).

One hundred twelve schools regarded themselves as regional or national leaders in these new endeavors (Item C).

Surprisingly, few respondents seemed to be willing to speculate as to which was "the leading institution in the U.S. in preparing teachers for the Information Age." No doubt Information-Age leadership was still in its infancy, and perhaps few educators had thought about national leadership in precisely this way before. Nonetheless, some "steeples of excellence" were apparently gaining recognition; the following schools were so identified by at least three of their peer institutions (Item S):

University of Oregon - 10 mentions
Indiana University - 6
University of Michigan - 5
George Peabody, Vanderbilt University - 4
Utah State University - 4
Teachers College, Columbia University - 4
Michigan State University - 4
Arizona State University - 3
Lesley College (Cambridge) - 3

The following schools were mentioned twice: University of Pittsburgh, University of Southern Alabama, University of Delaware - Newark, Stanford University, Florida State University, University of Wisconsin - Madison, and the University of Houston. In all, 48 schools were nominated as a national leader by at least one respondent.

Most of these schools made no claim to such leadership for themselves. Interestingly, a number of institutions that perceived themselves as national or regional leaders were generally not so reported by peers. In many of these latter cases, avant garde work may be underway that is not yet widely known.

No single region of the country seemed to hold an edge in providing leadership in this field. Responses came from all sectors, and leaders could not be identified with any particular geographic area.

Using Information-Age Technology to Teach

The responding schools gave themselves fairly high marks in claiming that "Our teaching facilities are equipped to permit teaching with Information-Age technologies" (Item D). This item invites further investigation because the technologies might be anything from slide projectors to multimedia conferencing systems. Unfortunately, these many choices could not be examined in detail in a brief questionnaire.

A companion item, "Our faculty use Information-Age technologies in teaching their courses" (Item E), was only slightly less well endorsed. Again, the answers were not easy to interpret, since even one or two instructors using an electronic device in their teaching might satisfy this statement for a given institution. However, it is evident that the institutions were unwilling to claim too much about either the modernity of their facilities or the use to which faculty put the newer technologies. It appears that, as could be expected, there was room for improvement.

Helping Teachers-in-Training Learn to Use the Technologies

This is the area in which the schools reported the most encouraging results. In general, the respondents gave themselves medium to high marks for incorporating at least one course of Information-Age instruction into the curriculum and providing labs and practice classrooms in which students could gain "hands-on" experience with the technology (Items F through H).

Of some surprise to the author, more than 200 schools reported that they were teaching "the use of computer tools, such as expert systems, in instructional design and development." (Item I) The introduction of expert systems, a form of artificial intelligence, into instructional development is recent and was thought to be basically limited to a few commercial firms. Perhaps the question was misleading, with respondents keying in on the phrase "computer tools."

Helping Teachers-in-Training to Function in the Information Age as Individuals and Citizens

Students' exposure to "distance education methods and systems such as telecourses, audioconferences, videoconferences, and the 'Star Schools' consortia" (Item J) appeared to receive the least emphasis in most institutions. "Interactive video, hypermedia, and knowledge navigation" (Item K) did not do much better. Although these technologies are probably among the most innovative and encouraging developments in education today, in the majority of institutions, teachers-to-be infrequently encountered them.

Most teachers-in-training evidently received only moderate exposure to "new developments in information-handling, record-keeping, reporting, and information processing (e.g., management information systems and executive support systems)." (Item N) Students' introduction to "recent developments in library science, on-line data bases, and information storage and retrieval (e.g., video discs, CD-ROM, and read-write optical storage)" was much more substantial, and in fact may be singled out as the major initiative at most of the respondents' schools in regard to Information-Age concerns. (Item O)

Helping Preservice Teachers Become Proficient at Introducing their Students to the Information Age

Most institutions appeared to believe that they were doing moderately well in providing instruction in "how to help young people prepare for the opportunities of the Information Age" (Item P). These results are encouraging if one believes that this is the single most important task of a school of education in these times.

Preparation of Teachers to Function in the Information Age

The schools appeared to be rather assured that their "students are leaving the program well prepared to take professional and personal advantage of the Information Age" (Item Q). However, few seemed entirely satisfied with their performance in this regard.

Inservice Training in Information Age Concerns

Most of the institutions gave themselves medium to high marks in recognizing their obligation to provide inservice training to teachers and administrators. No effort was made in this instrument to inquire what they were doing in this respect nor how well they believed they were doing it.

Respondent Comments

Not surprisingly, but dismayingly, a number of respondents indicated that they were fighting lonely battles with colleagues or administrators who either did not comprehend the importance of the issues or who failed to accept the relevance of Information-Age matters to their mission. A number of responses were unmistakably from individuals speaking for themselves and not for their institutions.

Institutional Detail

A number of respondents furnished descriptive information about their programs. Some of the more interesting:

- Dr. Perry Riffel of Valparaiso University, Valparaiso, Indiana, furnished a copy of the syllabus of his course, "Microcomputers in Education."
- Dr. Les Blackwell, chair of the Department of Educational Administration and Foundations at Western Washington University, sent a copy of the School of Education's computer competency requirement that is intended to ensure the student's self-sufficiency in computer use, provide an understanding of how the computer works, enable the student to use the computer as a tool, and prepare the student to use computer technology in education.
- Patsy Brooks of Alverno College, Milwaukee, sent a syllabus of her course in "Instructional Media." In the Introduction, she contends that "The teacher in the latter part of the twentieth century has a vast array of materials available to her, yet never has her role in structuring learning been more critical." One of the foci of her course is a "synthesis of communication theory and instructional theory."
- Dr. David E. Cook, Academic Vice President and Provost for Dakota State University, Madison, South Dakota, furnished a copy of his institution's 1989-1990 "Catalog." Page 134 cites the "Mission Statement for Teacher Education" which, in part, states:

> *"To the traditional course of study designed to prepare prospective teachers with in-depth subject knowledge, Dakota State University also adds course work in computer skills that enable the graduate to employ the instructional and learning resources made available through today's technology. Education majors complete a core of computer courses in computer applications and programming. Additionally, the teaching methods courses demonstrate the integration of computers into academic subject areas."*

Majors in education were expected to be able to evaluate computer hardware and software, "plan appropriate uses for computer integration in the classroom," and use both common applications programs and programs designed specifically for such educational applications as grade-keeping, lesson planning, and inventory.

Several institutions reported receiving grants to strengthen their Information-Age efforts. Some examples:

- Dr. Roger Wess, professor of education at Chadron State College, Nebraska, wrote that "Chadron State College is in the last year of a $150,000 Title III Grant to develop a Model Information Classroom. The purpose of this facility is to demonstrate various ways technology can be used to support and enhance instruction. The audience includes students in teacher education programs, college faculty, as well as educators from surrounding elementary and secondary schools."

  Dr. Wess also described a grant to conduct a Regional Course Sharing Through Technology Pilot Project, together with other developments at Chadron State.
- Dr. Martha Gage, chair of the Department of Education at Ottawa University, Ottawa, Kansas, reported the receipt of a $2.5 million Title III grant to "enhance and integrate the use of technology in our classrooms." She noted that her marks on the survey were low, but "given another 6 months to a year my responses would probably be quite different." [letter, January 18, 1990]
- Dean Gene Hall of the College of Education at the University of Northern Colorado, Greeley, was one of several respondents who could report financial assistance from the private sector. In his case, he stated that Northern Colorado was participating in a large U.S. West project for telecommunications that would aid their students in understanding distance education. The College of Education also maintained UNCLE, the UNC Link to Educators, an electronic bulletin board service for educators and students in the Rocky Mountain region.
- In reply to the query about the retraining of faculty, Dr. Robert Lucking, of the Department of Curriculum and Instruction at Old Dominion University, Norfolk, noted that, "We secured a $200,000 grant from IBM and part of these monies are dedicated to travel expenses for training provided to faculty. Several other faculty have begun training for use of the new lab this grant will provide." [letter, received March 26, 1990]
- Associate Dean James E. Richmond of California State University, Chico, noted that, during 1988-89, California's Farr Act provided funding and incentive for faculty retraining related to the new technologies. About one-half of the faculty of his College of Education participated by attending campus and state workshops and training sessions or by going to "national meetings focused on the use of computers in teacher education." The campus also cooperated with the California Technology Project and the Association of State Technology Using Teacher Educators (ASTUTE) to provide additional training for the teacher education faculty. [letter, March 19, 1990]

Summary

In sum, the Information Age was arriving, if somewhat unevenly, at many of the schools of education in the United States at the time of this study. Its appearance was not welcomed by all teacher educators, and its implications were probably fully apparent to none of us. It was far from the central activity or concern of any institution. Neither society nor education had been transformed by the new age, but of course it was too early. Unfortunately, although there were encouraging exceptions, education as represented in the teacher colleges seemed insufficiently moved by information and communication developments in the wider society.

At the time of the survey, genuine national leadership of the newer developments had not yet crystallized, but seemed to be emerging. There seems reason to hope that societal pressures will reshape educational practice in the decades ahead, and that teacher preparation, however it comes to be practiced, will act both appropriately and proactively.

Acknowledgement is gratefully made to Dr. James F. Comes of Ball State University for helpful suggestions and interpretations of the survey results.

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Minimal to Maximum Computer Usage in a Three Year Period

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Abstract

Teacher Education at Urbana University went from minimal computer usage to a futuristic approach in a three year period. The educational uses of the computers stem from a campus-wide computer policy. The Division of Education offers a variety of computer uses to its 135 students. *Microsoft Works* and *Hypercard* became the focal points for teacher-made materials.

This manuscript is about the usage of computers in a teacher education program at Urbana University. It deals with descriptions of how a computer model became operational for short and long-range plans. The model is unique in that it stemmed from a campus-wide policy, which was the result of a $75,000 training grant from the Lilly Foundation for a three year period—1989 through 1992. All university divisions have supported this educational computer plan.

Urbana University is a small institution with a total number of nearly 1,000 students. It possesses a strong base in a liberal arts tradition that dates back to 1850. Teacher education enrollment has a total of 135 students. The campus is located on 125 acres in rural Champaign County in central Ohio.

The components of this evolving computer model include commitment to the use of and establishment of computer policy and expanding classroom applications via the computer. The model plan actually began in 1988 when the President, Paul Bunnell, of the institution announced in his address to faculty that Urbana University would make a commitment to maximize usage of computers in its programs.

In 1989, the initial steps were taken for integrating campus-wide usage of computers in this Liberal Arts setting. Four faculty members were selected to form policies for training faculty. Field trips, hiring consultants, and training sessions were planned and implemented for a three-year period.

The four faculty members held frequent meetings during the first year. In addition, the institution's Vice-President, Harold Dickerschield, assisted the four committee members in making decisions and policies. One significant policy was that Microsoft Works became adopted as a campus-wide application. The four faculty mentors took part in a training session on the word processor, data base, and spreadsheet from a commercial firm. Other faculty members were encouraged to use the tutorial version of *Microsoft Works*. Ten percent of the faculty viewed this package.

Accomplishments via computer were slow to develop during the 1989-90 school year. The computer committee took a bold step by developing a plan for faculty to take a five-day workshop on usage of the word processor. A committee member from the Division of Math and

Sciences led these experiences. Thirty-three percent of the faculty participated in these hands-on projects involving the microcomputer. This major accomplishment took place during the Summer of 1990.

Having met their major goal, the computer committee found a sense of direction. Planning became more specific. The Division of Humanities developed a Writing across the Curriculum project that involved the computer. This project won committee support in the early Fall of 1990. This computer writing project was implemented with 100 percent participation of the total Urbana faculty during the 1990-91 school year.

The Division of Education began to exert campus-wide leadership in computer usage during the 1990-91 school year.

One faculty member attended a national conference on computer use in education. The Divisional Director took part in a state conference concerning educational technology in Florida. Upon his return to the campus, the Director emphasized that the Urbana education program would develop a technology room for students. Such a center would serve the present needs of students and, hopefully, their future needs towards the year 2000. One hundred percent of the education faculty learned to use the Macintosh computer in an all day training session at a nearby educational center.

Education faculty also accomplished other computer goals during the 1990-91 school year. *Hypercard*, *PageMaker*, and videodiscs were studied and explored. A computer lab containing seven Macintoshes was established in the newly created technology room. The faculty helped to finance the costs of this room and worked to remodel it in order to make it a noteworthy innovation useful for classroom instruction.

One education faculty member began to offer a variety of computer experiences to many people during the Winter of 1991. A pilot project concerning the utility of computers in education began with three people. Seven students enrolled in an undergraduate class, while one graduate class had an enrollment of thirty people. In addition, a College for Kids program provided training for eighteen students ranging in ages from 8 to 14 years old. Seven undergraduate students exhibited their computer-art pieces at a national convention in Phoenix, Arizona.

The Summer of 1991 was a significant time for Urbana University. Twenty-five percent of the total faculty attended national conventions involving computer usage. Momentum for the computer as an instructional tool became evident. A group of four professors informally talked about classroom situations that could be enhanced via the computer. This group also became challenged to write a national proposal for a computer presentation at a national forum.

The Divisions of Education, Humanities, and Social Sciences undertook common goals for classroom applications of the computer. Mental resistances to computer usage were being overcome because of the solid foundation formed in 1989. The faculty members began to see that the visual format of the computer may serve as an important function in a broad curriculum. Faculty became further exposed to a number of specific applications for computer usage in the classroom. They became familiar with a variety of software for effective instruction through such programs as desktop publishing, interactive approaches, videodiscs, bar-codes, *Hypercard*, and drawing programs.

Competencies of faculty emerged from training in computer technology. Sixty percent of the education faculty and fifty percent of the entire faculty had the experience of learning to manipulate videodiscs. Computer generated materials for the classroom were developed in History 121, Education 101, and Education 201. Six accelerated students (with degrees retraining to be teachers) undertook a variety of computer projects. Community education classes using the Macintosh became established for seventeen interested persons from other schools in locations outside the University.

Additional results of computer usage in three divisions are being compiled. For example, one Humanities professor of the University plans on using the computer interactively with videodiscs in discussion and debate in the area of religious studies. Social science professors now have the foundation to make academic presentations from computer generated materials. One history professor has training on interactive uses of the computer. All faculty members in Education are adopting software materials for the curriculum in the teacher training program.

The highlight of 1991 occurred when Urbana University was notified that its proposal was accepted for a national presentation during March of 1992 in Houston, Texas. The morale of both faculty and administrators became higher as results of their program became more and more evident. We at Urbana now realize that our past and current struggles are being rewarded as future goals using the computer will be recognized beyond the immediate campus area.

In retrospect, a small beginning of minimal computer usage has changed to maximum computer usage at Urbana University. The computer model emerged from initial commitments. Broad computer policy gradually provided a framework of mutual understanding and cooperation among people in the University setting. The computer is now being viewed as a tool for effective instruction in classroom situations.

Maximum computer usage will continue at Urbana University. A high percentage of all faculty in all divisions will use the computer. A higher percentage of students will be using computers in advanced forms of technology. Students and faculty will increasingly use the computer as interactive forms of classroom presentations.

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Preparing a College of Education for the 21st Century

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Abstract

In 1976 the College of Education at the University of South Alabama appointed a new Dean. Beginning immediately, the college began to prepare for the instructional and educational technology that would become affordable and available as a result of large scale integrated circuit technology. Using a model comprised of Vision, Strategy, Projects, and Tactics, the successes, failures, false starts, and problems associated with preparing a College of Education for the 21st Century will be described. Specific projects are described, as is the composition of the "dream team" that can provide success. ("You need a visionary, a missionary, a politician, and an SOB. And the more missionaries, the better!") Also described are the curricular and personnel changes required by the infusion of technology into a formal program of teacher education.

The Vision

We are trying to do some things differently in teacher education at the University of South Alabama. We think we are succeeding.

Most colleges of education develop traditional doctoral programs, training school administrators, curriculum specialists, counselor educators, and the like in a manner—and often in content—they have been trained for fifty years. Rather than duplicate doctoral programs in existence across the state and nation, we chose to develop one doctoral program—a Ph.D. in Instructional Development—modeled after the Instructional Design and Development program at Florida State, Syracuse University, the University of Georgia, and perhaps a dozen other universities in the United States. Unlike those programs, however, this is the only doctoral program we will support, and we will (a) place all of our available resources and our most qualified faculty into the effort and (b) involve faculty from a wide range of departments and divisions within the University.

We are committed to the belief that the public schools of our nation cannot be improved substantially unless we can change the basic approach that is taken toward instruction. For example, formal education is the only learning environment that is virtually completely controlled by calendar considerations. Introduction to high school chemistry, for example, is taught one hour per day, five days per week, for 36 weeks. Given appropriate flexibility and learning options, some students might complete the course requirements in 18 weeks; others might achieve competency if they were provided, for example, 44 weeks. The basic key to traditional curriculum building is to fit a course—usually defined by the chapters in the selected textbook—into an 18 week or 36 week unit. We believe we have the knowledge, and now the affordable technology, to make major changes in this traditional approach.

We are committed affirmatively to opening the field of instructional development to women and minorities by recruiting and supporting these individuals in our Masters and Ph.D. programs in instructional development.

We are committed to applying what we know about instructional design and development to our own college and university courses. We are already participating in a curriculum review and instructional development effort with the Department of Family Practice in the College of Medicine and have active program development efforts continuing with faculty from the Department of Art, Department of Music, and Department of Physical Therapy.

We are further committed to working with public schools in the district, region (Moss Point, Mississippi), and state (Alabama School for Math and Science) to demonstrate the effectiveness and feasibility of our beliefs. This last year we were awarded a major three-year contract from the National Science Foundation to work with Vanderbilt University to integrate interactive videodisc instruction in mathematics into the elementary schools of Alabama.

We currently have fifty-five full-time faculty members. The vast majority of these are computer literate in that they use computers to improve personal productivity and professional presentations. Within this group are individuals who are developing multimedia, computer-enhanced instructional modules. With retirements, resignations, and new positions we will probably add a dozen new individuals over the next two years. We are committed to finding faculty members who share our vision and can contribute to our effort.

Strategy

Faculty Development

Faculty development efforts have continued to be a major focus during the second year of the BellSouth grant. During that time CREDITT has provided 728 hours of faculty inservice activities to 44 different faculty. In addition, CREDITT has supported 8 faculty in attending national or regional workshops and conferences.

Interest from other colleges within the University has shown a marked increase during the past year. Participation in CREDITT workshops and courses has come from the Department of Art and the Department of Music in the College of Liberal Arts, the Computer Science Program, the College of Engineering, the College of Nursing, the University Computing Center, the Personalized Study Program for Adults, and the College of Allied Health.

Efforts have begun to establish a permanent, University supported, office of Faculty Development in Educational Technologies. At the request of the Vice- President for Academic Affairs, the College of Education has developed a series of workshops that will introduce faculty from all colleges to the use of new educational technologies in their classrooms. These workshops will begin in the fall of 1991.

Efforts to establish a joint program with the Art Department in Multimedia are beginning to bear fruit. College of Education multimedia courses are now officially recognized as part of the Art Department curriculum.

An additional software program developed by a College of Education faculty member has been published and is being distributed nationally as a result of training provided through CREDITT with BellSouth support.

Projects

Validating the Use of Hypermedia in Elementary Mathematics Education.

National Science Foundation Grant #TPE9053826 ($875,000). This a three-year project designed to restructure the teaching of mathematics education in Alabama's teacher education program. This NSF project features a statewide network of eleven institutions, guided by the University of South Alabama, in the use of interactive laser videodisc technology. In addition to the NSF resources, Apple Computer, Inc., donated approximately $50,000 of computer technology to the project.

Using Videodisc Technology to Enhance the Teaching of Elementary Mathematics for Beginning Teachers.

Eisenhower Math and Science Project ($38,000). This Title II project is designed to provide professional staff development training for elementary teachers across the State. The Project has developed computer programs to support interactive laser videodiscs currently in use in the NSF project. The Eisenhower Math and Science has statewide implications as the University of South Alabama has responsibility for providing instructional materials, training, and technical support to the ten universities subcontracted to help deliver the instruction.

Moss Point (MS) Multimedia Project ($10,000). This fixed cost contract provides technical assistance to the Moss Point (MS) School District in the area of computer technology and curriculum development. Working with the Moss Point High School faculty, College of Education faculty and staff members have developed student-based multimedia projects that have enhanced student learning. The Project's success is evidenced by the fact that the school district is planning to enter into a contract for 1991-92 academic year for approximately $20,000.

South Alabama Research and Inservice Center. The South Alabama Research and Inservice Center (SARIC) is in its 7th year of funding. Serving over 6,000 teachers and administrators, SARIC is the major field-based outreach program of the College. During the 1990-91 academic year, SARIC provided over 20,000 hours of staff development for area educators. The service area for SARIC includes Mobile County, Baldwin County, Washington County, Monroe County, Clarke County, and Thomasville City School Districts.

The Center provides programs that focus on mathematics, science, computer technology, and other critical needs curriculum areas.

New Building Plans

For the past several months, individuals and committees in the College of Education have been working with architects to develop specific plans for the newly renovated College of Education facility located in a portion of the Kingswood Campus. Summer or fall of 1992 is the target date for relocation into the facility. The facility will provide room for teaching, research, inservice education, program development and demonstration, and limited faculty and staff growth.

Ph.D. Program

Faculty continue to work on the development and refinement of a Ph.D. in instructional development. The proposal will be reviewed by the Academic Affairs Committee of the Alabama Commission on Higher Education on June 20th and by the full Commission on June 21st. (The program was approved by a vote of 7 - 2 by the full Commission on June 21, 1991.)

State Activities

In March 1991, the College of Education began holding monthly demonstrations for teachers in new ways to use technologies in the classroom. McGill-Toulin High School in Mobile has arranged for teachers from one of their curriculum departments to attend these two hour sessions each month. Teachers from the Birmingham Montessori School attended the March session. Participants from schools in Escambia County, Florida, and Lake Charles, Louisiana are expected to attend the May and June sessions. We expect these sessions to expand as their availability becomes more widely known.

Rural Initiatives

Moss Point

In July 1990, after many unsuccessful attempts to identify potential partners in a rural initiative, we began a program with the Moss Point, Mississippi Public Schools to train two of their teachers and one administrator (Assistant Superintendent for Technology) in the use of new technologies for educational purposes. A series of meetings were held to assist the Moss Point Schools in identifying the hardware and software they needed to participate fully in the program. Moss Point then purchased some $200,000 of software and hardware as specified by Dr. Strange and Dr. Feldman of the University of South Alabama. Efforts were undertaken to secure support for continued inservice training by University of South Alabama at Moss Point. This was accomplished with a grant from the Mississippi Foundation for $10,000. In early October, the University of South Alabama began providing regular, on-site support for Moss Point's activities.

There have been two major foci to date at Moss Point. First, all freshmen are being taught word processing in a new Macintosh laboratory installed at the high school as a part of this program. Second, the students on the Yearbook staff have been given special training in multimedia and are currently developing a series of products, including films, music, print materials, animations, and other multimedia products, that will be used in a variety of applications, including the production of a video yearbook, for the school.

Initial results of the effort are very positive. Demonstrable reductions in tardiness and absences, increased attention to school work, a significant increase in enthusiasm and positive attitudes toward school work, and improved grades have been reported for many of the students involved in the project. Data are being collected as the project proceeds to provide evidence of the long range impact of the program. The Mississippi Foundation has been so pleased with the activities begun at Moss Point that they have provided an additional $10,000 grant to support the program.

Additional training has taken place of the school faculty and staff in the Winter and Spring Quarters and will also take place in the Summer Quarter. In late September 1991, a series of workshops will be held at the Moss Point High School for principals and superintendents from rural areas in Alabama and Mississippi that make up the service area of the University of South Alabama. The workshops will focus on techniques to help the participants learn how to use new technologies to improve teaching and learning in their schools.

Monroe County Public Schools and Monroe Literacy Council

A second rural initiative was begun in January 1991 in cooperation with the Literacy Council and the Public Schools of Monroe County, Alabama. Faced with low reading skills among large numbers of their students, the Monroe County Schools conducted a survey to ascertain the extent of illiteracy among the parents of students enrolled. In several schools in the district, the illiteracy rate of parents of enrolled students approached 70%. The University of South Alabama has begun an attempt to address these problems using technology. In March 1991, a voice activated reading program was installed in the Monroe County Schools with voice recognition equipment and reading programs loaned to the University of South Alabama by Optimum Resources, Inc. and computer equipment loaned to the Monroe County Schools by IBM and AC-3. In addition, the College of Education University of South Alabama is undertaking research into the feasibility of using voice recognition technology to teach reading skills to elementary and secondary students as well as to their parents.

These efforts have just begun, and initial reports indicate that voice recognition equipment may offer some assistance in teaching reading, but that other approaches are also necessary.

New CD programs with great promise for improving reading skills were released in February 1991 by a company based in Canada. The University of South Alabama immediately secured these programs. A demonstration of them was held for the Director of the Monroe Adult Literacy Council and the President of the Alabama Pulp & Paper Corporation in early March. As a result of that demonstration, the Alabama Pulp & Paper Corporation has agreed to purchase the hardware necessary to run these programs and will donate it to the Monroe Adult Literacy Council. The College of Education, under the BellSouth grant, will provide additional software and will also provide training for representatives of the Adult Literacy Council and the Monroe County School System who will be using the equipment.

We will soon attempt to develop a joint proposal for funding of additional work in this area. A possible source of support is the Landegger Foundation which has made major grants for literacy improvement efforts to both the Monroe County schools and the Monroe Adult Literacy Council.

Tactics

We are designing a high-tech learning center in a former shopping center that now forms the southeast corner of our campus. This facility is being designed to take advantage of the technologies that are now available and what we know about improving the teaching and learning environment. The College of Education will move into that facility in late 1992. Once operational, we plan to make this learning facility available to inservice teachers and administrators and interested business and industry groups in the region.

We have used the Adjunct Research Professor strategy to enhance our faculty and student development efforts. For example, Dr. Patrick Griffin, President of Griffin-Johnson of Washington, D. C. and formerly Secretary to the U.S. Senate Minority, serves as Adjunct Professor of Educational Policy Studies; Dr. Louis Gottlieb, founder of and—for the past 30 years—performer with the Limeliters, serves as Adjunct Professor of Music Education. Dr. Martin Haberman of the University of Wisconsin - Milwaukee, who has been on the cutting edge of teacher education reform for the past thirty years, serves similarly. These individuals are typical of many who share our vision and support our efforts in their own way.

We have worked for nearly fifteen years developing this vision and instituting the strategies and projects that have gotten us to this point in our development. We have had help from groups like the BellSouth Foundation who provided us with substantial funds for faculty development, from IBM who provided us with an up-to-date, networked, instructional classroom, and Apple Computer who provided us with the hardware and—perhaps more importantly—with the encouragement to pursue our strategy to begin faculty development by focusing on personal productivity and professional presentation skills. We have also had the valuable insight of a wide range of individuals from the profession and from business, industry, and the military, twelve of whom currently serve on our National Advisory Council (a roster of the membership is attached at the end of this document) and provide direction for the instructional development efforts.

We know that the Ph.D. program and the college vision we have chosen is resource-hungry. We have assessed a student-laboratory fee on nearly all of our courses. This generates approximately $120,000 a year, of which the College of Education receives $80,000 directly to maintain the laboratories and keep them open for extended hours under supervision. We are always looking for funds or equipment donations that can support our mission.

Within the university there are several very talented women and minorities in non-tenured positions, or in positions of tenure, who do not hold the Ph.D. We are looking for annual and summer salary support for some of these individuals to pursue doctoral study.

We have a National Advisory Council for the Ph.D. program that we would hope to convene once a year in Mobile.

We intend to pursue avenues to provide fellowships specifically for women and minorities in the masters and Ph.D. Instructional Development programs.

We are pursuing any type of support for cooperative endeavors with local

K -12 schools and districts to improve the quality of instruction through the use of instructional design and information technology.

We have a number of ideas to improve education in Alabama. These require bringing together decision makers (school district board presidents, superintendents, principals, and instructional leaders from schools). One major theme will focus on ways to improve the educational opportunities for the rural poor in Alabama.

Of course, we have our "big dreams," too. One is to establish one or more distinguished professorial chairs in the field of Instructional Design and Development at the University of South Alabama. A typical chair of this type requires a million dollar endowment. We believe we can leverage the university and the state into matching donations on a dollar-for-dollar basis.

National Recognition

The College of Education's efforts in educational technology have begun to receive national recognition. In a survey of all Deans of Education in the United States conducted by Ball State University to identify which schools are perceived by peers to be leading examples of using technology to improve education, the College of Education of the University of South Alabama was identified among the top 20. Carl Franklin and Susan Kinnell, in their recently published book *Hypertext/ Hypermedia in Schools: A Resource Book* (ABC-Clio, Santa Barbara, 1990), use the multimedia program of College of Education at the University of South Alabama as an example of the courses being developed and offered for teachers.

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Effective Integration of Software: A Design for Teacher Training

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Abstract

Among the challenges American public schools and educators face is how to effectively integrate into the classroom the modern technologies available that can assist in achieving instructional goals. To achieve the full utilization and impact of microcomputers and other technologies on the classroom setting, educators must realize the potential impact technology can have on their classrooms and students. Educators need to obtain the skills necessary to operate the technology (hardware and software), to facilitate instruction using the technology, and to teach their students how to use the technology effectively for guiding their own learning. A design for teacher training on skills involved with integrating software into the mathematics classroom is presented. The implementation of this design and results of participants evaluations are presented.

As American public schools approach the twenty-first century, many challenges are faced. Among these challenges is how to effectively integrate into the classroom the modern technologies available that can assist in achieving instructional goals. The most recognized symbol of high technology, the microcomputer, is a common feature in the school setting. However, with a few exceptions, the full utilization and impact of microcomputers and other technologies on the classroom setting has not yet been realized.

In a recent survey, teacher education programs were evaluated for the effectiveness of the technology preparation training offered to preservice and inservice teachers. Ten of the twelve aspects covered by the survey received favorable results, however teacher technology preparation received a failing grade (Fulton, 1989). The single most pervading issue in colleges of education today relative to technology is the integration of technology into the teacher preparation curriculum (Bitter & Yohe, 1989). Gooler (1989) discusses a report from the Office of Technology Assessment that details the tremendous potential technologies have in education. The report also suggested that most teachers want to use these technologies, but, unfortunately, they do not feel adequately prepared. Given this information, preservice teacher education programs need to be redesigned so that they can provide future educators with the amount of instruction required to successfully integrate and apply technology in the classroom (Bitter & Yohe, 1989; Zvacek, Bauer, & Grzenda, 1991).

For these newer technologies to emerge as instruments of curricular change in classrooms, educators must realize the potential impact technology can have on their classrooms and students. Educators need to obtain the skills necessary to operate the technology, to facilitate instruction using the technology, and to teach their students how to use the technology effectively for guiding their own learning (Smith & Westhoff, in press).

The training involved to accommodate these skills is an ongoing endeavor and encompasses a variety of technologies. While there are textbooks and entire college courses that discuss this type of training, this discussion will address only one aspect of the training: the integration of software into the classroom.

Teacher Training Workshop

A teacher training workshop was designed and presented by the author to inservice teachers during the summer of 1991 as part of IBM's summer technology classes offered at the IBM Denver Tech Center offices. The one day workshop concentrated on using IBM's secondary mathematics programs: *Mathematics Explorations Toolkit, Algebra I and II, Geometry I and II*, and the *Mathematics Basic Skills* courseware. *Mathematics Exploration Toolkit* is a multi-purpose package that can be used in courses ranging from introductory algebra to calculus. The Algebra and Geometry series can be used in both middle school/junior high classes as well as high school courses. The *Mathematics Basic Skills* courseware concentrates on the skills developed in pre-school through middle school/junior high classes.

The workshop was designed to encompass the following goals:

1. The training workshop will give participants hands-on experience using all four software packages.
2. The training workshop presenters will model effective methods of integrating the software into the classroom through sample lesson plans and interactions with the participants.
3. Participants will gain insight into the relevance of integrating technology in their classrooms.

The limited time to deliver the instruction and the amount of material to be presented made it essential that the design of the workshop be carefully considered and implemented. Given these constrains, the goals of the workshop, and the unknown experience level of the teachers that would be attending the training, Reigeluth's elaboration theory (1983, 1982) was selected as the design model.

Design

In designing the teacher training workshop, the initial step was to determine the level of experience the teachers would bring with them to the training. The description of the course, included in an information sheet mailed to school districts, described the course as an introduction to the uses of the secondary mathematics courseware. From this description it was assumed that the majority of participants would have limited experience with using technology in their classrooms, although some would attend to update their skills and see additional ways to integrate software into their mathematics classrooms. Once the participants experience levels were estimated, the next step was to determine the overall design of the workshop.

The design of the teacher training workshop followed the *general-to-detailed sequence* prescribed within elaboration theory. This sequence starts with an introductory lesson which presents the material in the context that is the most representative of or fundamental to the material. This includes relevant information and the selection of ideas most instrumental to achieving the goals of the training. The information and ideas will help formulate and assist in the creation of a single theme. This theme or organizing content is referred to as the epitome (Reigeluth, 1983, 1982). The remainder of the training sequence is designed to progressively present more detailed information that elaborates on this epitome or theme. Each elaboration or lesson can contain multiple levels, with the levels being arranged in increasing layers of detail and complexity.

For the teacher training workshop on the secondary mathematics courseware, a foundational session was first presented covering access to the network and the software. Following this initial hour presentation, three sessions were presented that elaborated on the concepts from each individual software package. The elaborations were presented in the form of the participants using the software and on various classroom applications of the software. The hands-on nature of the training workshop allowed for interactions with the software through the use of sample lesson plans. The lesson plans were design with two purposes in mind. First, the participants were guided through a lesson plan as if they were students themselves, gaining the perspective of how a student uses the software. Once the participants acquired this perspective, they were guided through the same or similar lesson plan, this time from the perspective of the instructor delivering the lesson. This second lesson or elaboration built upon the student perspective acquired in the earlier lesson. Additionally, the participants were guided through the creation of their own lesson plans and interactions that were tailored to fit their specific needs and situations.

Between each of the four sessions and between the levels of lessons or elaborations presented, time was provided for the participants to ask questions, explore the software package and material covered thus far, and become increasingly comfortable with the technology through their own discovery learning.

Implementation

The teacher training workshop was presented during one day from the hours of nine to four at IBM's Denver

Tech Center offices using networked PS-2 computers. The training had four main components. The first session was an introduction to using the network and the foundational sequence that establishes the epitome, the presentation of ideas most instrumental for achieving the goals of the training. This session was followed by three sessions presenting lessons and elaborations on each of the software packages Mathematics Explorations Toolkit, Algebra I and II, and Geometry I and II.

To establish the theme of the training workshop, approximately one hour was devoted to introducing the participants to the operation of the software package Mathematics Exploration Toolkit. The skills needed for the operation of this software package are similar to those of the other software packages. The participants were exposed to the instructional environment created by the software and guided through an investigation of the features inherent to all of the software. Examples of how to manipulate the environment were also included. For example, CALC is a feature that, in addition to other operations, allows the user to enter an equation, graph that equation on part of the screen, then manipulate the equation to see the effects different values of the variables has on the graph of the equation. The material presented during this introductory session concentrates only on the skills necessary to operate the technology, the epitome. The participants were given time to explore this new environment and ask questions before the workshop continues. It is during the remaining sessions of the workshop that specific examples and lessons demonstrating effective classroom integration of the software are presented.

In the session following the introductory information, the first lesson or elaboration involves taking the participants through a sample lesson plan for solving radical equations using the *Mathematics Exploration Toolkit* software package presented in the early session. The participants complete the lesson from the perspective of a student. As they complete this lesson, the participants add to their knowledge and experience ways the software can be used in the classroom. Once this lesson has been completed and any questions answered, the participants were lead in a discussion of possible uses of this lesson plan within their classroom settings. After a short discussion, the participants were guided through the same lesson plan for solving quadratic equations from the viewpoint of an instructor or facilitator of the learning situation. Appropriate techniques and methods for using the lesson plan within the software package were modeled and discussed. Changes, if any, required in the normal classroom routine, setting, or presentation for the lesson plan to be successful were also discussed. For example, to present the lesson plan to the participants from the perspective of an instructor, the scenario of a high school algebra class was used to establish a classroom setting. The issues involved with integrating the technology into this classroom setting were presented, discussed, and modeled.

The final lesson or elaboration guides participants in the creation of their own lesson plans and interactions with the software and technology. For the Mathematics Exploration Toolkit software, participants develop a brief lesson plan for graphing linear inequalities. After the lesson plan has been developed, the software was incorporated into the lesson so that it would assist in the learning process, and then the participants observed as the lesson was delivered. During this task of creating a lesson, the feature of writing defer sequences or macros as an additional capability of the software package was demonstrated and briefly explored. The defer sequence is a powerful way to create and present lessons and information. These defers or small programs can be designed to interact with the user, asking them to respond to the questions and information presented. While being relatively easy to understand, this feature was not a focus of the training, since it accommodates a more experienced user.

The remaining sessions of the training workshop followed a similar design for the algebra and geometry software packages: First presenting the software from the perspective of a student user, then from the classroom application perspective of the instructor, and, finally, from the viewpoint of creating a lesson plan using the software within a classroom instructional sequence. The sequence used in the training lessons for the algebra series involved graphing linear equations using the slope and intercept values. The participants were walked through an exercise in graphing several equations using the algebra software, observing the variations in the graph as the values of the slope and intercept were manipulated. The participants explored the software, graphing both linear and other non-linear equations, just to see what the software could do.

After the explorations with the equations were completed, a classroom application for integrating this lesson plan was modeled for the participants. The application included a worksheet designed for the learner to identify the slope and intercept of a line from both the equation and its graph. The worksheet also asked the learner to describe how changing the slope affects the graph of the line. The worksheet was used to demonstrate how traditional classroom teaching methods can be enhanced with technology. Graphing equations can be a time consuming task, but by using technology, it can become an activity which facilitates a wide range of learning.

The final elaboration within the algebra training involved creating an interaction for showing the intersection of two linear equations. The participants designed a lesson plan, indicated how the technology could be integrated into the instruction, then were guided through the creation of two defer sequences (short programs) that were linked together to present the lesson plan from within the software package. These short programs asked the user to input values for the slope and intercept to two linear equations. After entering go (F8), the equations were graphed, and the user was asked to find the point of intersection.

Throughout the training, the lesson plans continue to link back to the foundational sequence that established the epitome. To begin each lesson, the participants start from the same point of the software package as was presented in the epitome. For each lesson, the same set of commands or procedures were followed to get to the desired level of the software package where the new elaboration would begin. Once at that level, the new lesson became an extension of the prior lessons. The links presented helped to focus the participants attention to the information they needed for achieving the goals of the training.

Evaluations

Upon completion of the training workshop, the participants were asked to fill out evaluation forms. These evaluations and suggestions from the first workshop, as well as the author's evaluations, were used in revising and delivering a second workshop two weeks later. Most of the revisions involved taking the lesson plans created during the training and the examples brought out in the discussions on how the software could be used in the classroom and adding them to the training packet.

Components of the workshop that the participants liked included the ability to apply the presented concepts immediately in a hands-on environment, the variety of examples presented, and the different sequences of lesson plans presented. Participants appreciated the time they were given to explore the software packages and walking through examples of what works and does not work in the classroom. Due to the fast pace of the training, most of the participants would have liked additional time, in the form of an additional day, to explore the software in more detail.

Conclusions

The use of the elaboration theory in the design of this teacher training workshop provided a model for which to take a large amount of information and a limited amount of time and place it into a structure that follows a general-to-specific sequence. This sequence proved effective for the delivery of the teacher training workshop due to the nature of the skills required for teachers to effectively integrate the software into their classrooms.

The training presented in this teacher training workshop is a step toward the solution to the challenges of effectively integrating software and technology into the classroom. In addition to the skills teachers acquire through training workshops, they must be exposed to the use and value of integrating technology into their classroom instruction (Heinich, Molenda, & Russell, 1989). For educators to become technologically equipped for the classroom, they need to have a basic understanding of the technology, recognizing the significance of technology, so they can update their skills throughout their careers (Bruder, 1989). The concerns identified by these authors were addressed in the design of this teacher training workshop. The value of integrating technology into the classroom can be demonstrated by using the technology to teach the use of the technology. Additionally, through the use of realistic examples, the significance of using the available technology in the classroom can be realized.

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Reviews of Instructional Computing Research: What Students Need to Know

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Abstract

All educators require understanding of the research base related to the application of computing technology to teaching and learning, so it is important to reduce this base of knowledge to manageable proportions for broad consumption. Indeed, synthesizing instructional computing research literature has been a popular pursuit. Many publications have appeared since 1972, ranging in rigor from very formal meta-analyses to very informal reviews. This paper evaluates and synthesize reviews of instructional computing research, presents major findings appropriate for inclusion in undergraduate and graduate computing courses for teachers, presents critical information important to the evaluation of this body of literature, indicates areas where more research is needed, and provides a bibliography of reviews of instructional computing research.

Introduction

As the age of technology becomes more of a reality for all educators, it is becoming increasingly important to incorporate into undergraduate and graduate teacher preparation courses the findings of research on computers in education. Unfortunately, research in the field is still nascent and courses for educators offered in many schools of education have given the research base insufficient attention. Until recently, this certainly has been the case in my own teaching. Since I have, over the past few years, taught every level (undergraduate, masters, and doctoral) of course offered in the instructional computing program, I have had occasion to consider, in collaboration with my colleagues, the appropriate inclusion of research-related issues. The purpose of this paper is to describe what my colleagues and I have done in this regard.

Cognitive and Curriculum Models

In order to be able to follow the thread of this paper, the reader must first understand two filters through which I have approached the matter: the cognitive model used for conceptualizing computer-based instruction and the curriculum framework upon which the course offerings hang. The cognitive model—that of computer-directed instruction (CDI), computer-enhanced instruction (CEI), and computer-managed instruction (CMI)—was described in this annual last year (White, 1991). For purposes of this presentation, it is enough for the reader to consider that the direction of instruction maps very well to the teacher's application of tutorial and drill type software encountered by students in Taylor's tutor mode (Taylor, 1980), and that the enhancement of instruction encompasses Taylor's tool and tutee modes, as well as all other direct instructional uses.

As to the curriculum model, three types of courses are offered: survey, topic-oriented, and process-oriented. The two survey courses (undergraduate and master's) attempt to take a broad, introductory, cross-disciplinary look at the entire field of instructional computing. The undergraduate survey course is the only undergraduate course that our department teaches and serves to acquaint all lower level students in the College with the applications of computers and related technologies to teaching and learning. The master's survey course suits inservice teachers seeking recertification in all disciplines and is also the introductory course in the M.Ed. program in instructional computing. All other courses offered at the master's level (some of which are also incorporated into some doctoral programs) are topic-oriented, focussing on development of competencies and skills in specific domains. Courses centered on such specific content as Logo, Interactive Media, Instructional Design, and Artificial Intelligence are typical of the topic-oriented courses, which number sixteen. There are currently only three courses overtly designated as doctoral level, and each focusses on the processes of scholarly inquiry in a specific domain: CEI, CMI, and using computers to implement educational research.

Research topics incorporated into the master's level topic-specific courses tend to be narrow in focus. The three doctoral courses, although almost entirely research-centered, vary greatly with the student's interests and focus on specific areas in much more detail than is possible here. This paper will address the incorporation of research topics into the survey courses.

Research Topics Appropriate for Incorporation in Survey Courses

I have found that three general classes of research findings are appropriate for presentation in the survey course: affective considerations, demographics, and cognitive considerations. My bias is toward the presentation of cognitive findings. This is not to say that information related to matters such as motivation, attitude, anxiety, equity (gender and SES), school uses, and access are not important. Indeed, such topics are discussed as the need arises at appropriate times (generally without references to sources), but the cognitive findings clearly have been my priority. The following are the cognitive findings that I have considered appropriate for inclusion in the survey course. For the reader's benefit, I have included in Table 1 a list of many references, other than those specifically cited in the text, that I have found to be of value in this pursuit.

Cognitive Findings on Computer-Directed Instruction

An analysis of CDI research syntheses (summaries and meta-analyses) performed from 1972 to the present revealed only two general findings that have received moderately broad acceptance. Even these two, however, are not universally accepted. In addition to these two generally accepted findings is a third finding that has recently been seriously challenged. The potential weight of all three of these findings must be qualified in light of a number of interesting facts. For example, only three of these syntheses restricted their scope to microcomputer applications: Becker (1988); Roblyer, Castine, and King (1988); and Gillingham & Guthrie (1987). All others have mixed mainframe, minicomputer, and microcomputer studies.

Some comments are also in order about the nature of the individual studies that are included in these syntheses. Most of them (75%) use proprietary software that is not widely available (Bangert-Drowns, Kulik, & Kulik, 1985). This is understandable, because the mechanical needs of research often demand the creation of software with specific features, but it has helped to create a situation in which there has been little research performed to replicate findings with the same software. Another interesting and related fact is that little CDI research has been conducted with regard to what has gone on before (Wedman, 1987). Again, this is understandable for such a new area of research in which a "broken front" of research on a widely varying array of topics is expected. Taken together, the two factors mentioned in this paragraph go a long way toward accounting for the paucity of general findings from CDI research, which follow.

CDI is overall at least as effective on achievement as traditional instruction.

This is the most broadly accepted of findings. It is important to note that the majority of the individual studies referenced in these syntheses are not microcomputer-based, use the mathematics content area, use proprietary software, and are mostly drill and practice with varying degrees of tutorial.

Roblyer, Castine, and King (1988) conducted a meta-analysis of 36 studies on CDI that supports this general finding, especially at the college and adult levels where an effect size of .57 was computed ($p<.05$). Similarly, a 1987 synthesis of 13 studies by Gillingham and Guthrie found an effect size of 1.36 for computer-directed versus traditional treatment. Although generally accepted, even this finding is not compelling. Most individual studies have generated small effect sizes, some are even negative. White (1983) suggested that research on CDI has been subjected to much greater scrutiny than the "traditional instruction " to which it has been compared. In a related opinion, Kulik and Kulik (1987) suggested that CDI may be effective simply because it is well-planned instruction.

CDI generally reduces learning time.

In a meta-analysis of 199 studies, Kulik and Kulik

(1987) reported an effect size of .36 (p>.10) for studies of less than nine weeks duration (n=79) and .27 (p>.10) for longer studies (n=114). For 28 studies, they estimated a 68% savings of instructional time in favor of CDI. Other syntheses such as Waugh and Currier (1986) and Parry, Thorkildsen, Biery, and Macfarlane (1985) performed no statistical analyses, but reported a preponderance of findings supporting savings of time with CDI.

CDI is most effective for low-aptitude students.

Many synthesizers of the literature have reported this finding, but in a recent, comparatively rigorous meta-analysis by Roblyer, Castine, and King (1988), the researchers found "No support ... for the hypothesis held by many in education that computers are more effective with low-achieving students than with regular students."

It is obviously dangerous to attempt to generalize any of these three findings to content areas other than mathematics. There is a clear and compelling need for research in other content areas. These studies and their context also draw attention to the need for researchers in this field to pay particular attention to creating studies that are replicable.

Cognitive Findings on Computer-Enhanced Instruction

There are no compelling findings to be presented regarding computer-enhanced instruction. There are, as yet, comparatively few studies in this area and, with the exception of some reviews of Logo research, to my knowledge only two reviewers of the literature have attempted to draw conclusions: Collis (1990) and Roblyer, Castine, and King (1988). It is important to communicate to students, however, that there is a paucity of information. There are a number of promising practices that have emerged which are very appealing on an intuitive basis, so it is important to communicate to students that the research jury is still not in. Each semester I find myself playing the grinch to students who, usually with very good reason, believe strongly in the value of one application or another, and for whom the research findings are hard to accept. The following are major points that I have found need to be made.

- **Conventional Wisdom: Learning with Logo makes students better problem-solvers.** The literature in this area is inconclusive. Given the history of research on transfer of learning, it is not surprising that the Logo studies have varied widely in their findings. Collis (1990) presented findings that are representative of most of the reviewers: Logo skills are not easily transferred; level of transfer is related positively to the teacher's instructional guidance; and the better designed and controlled theresearch, the less likely a significant finding. Roblyer, Castine, and King (1988), however, found a "substantial and homogeneous effect for Logo" upon enhancing problem-solving skills and upon creativity.
- **Conventional Wisdom: Graphing mathematical functions with computers will result in better success in Algebra and Trigonometry.** Findings in this area are few and inconclusive. Roblyer, Castine, and King (1988) report that students in one study tended to like working this way and also tended to produce more practice problems.
- **Conventional Wisdom: Writing with computers will result in more prolific and better writing.** The case for better writing through word processing has been a weak one. Collis' (1990) findings, again, were very typical of what most reviewers have concluded: Children tend to like writing better when word processing, but tend not to make effective use of word processors without explicit instruction about the use of writing process skills, such as revision, away from the computer. Roblyer, Castine, and King (1988) found that "effects seem small at this time in this area."
- **Conventional Wisdom: Use of simulations in science and social studies will result in more concrete understanding of relationships among entities in a system.** Although there are some individual reports, none of the reviews listed here stated a finding regarding social studies simulations. For science, however, it appears that common wisdom is being supported. Collis (1990) reported that effects were promising, with the qualification that substantial teacher guidance must be given, and Roblyer, Castine, and King (1988) found very large effects over four studies.

Methods of Incorporating Research Topics in Survey Courses

Having stated which findings are appropriate for inclusion in the survey course, how does one incorporate them into the curriculum? What I have to say here is not at all innovative. At the undergraduate level, presentation of the findings is simply integrated into the general presentation. For example, a presentation on instructional applications of word processing leads naturally into a discussion of related research findings.

The same technique is employed at the master's level, but the topic is then pushed further by requiring of each student an analysis and synthesis of research literature in a specific content area. Brief class presentations by each student lead very well into a general discussion of findings that cut across content areas and the overall status of research on educational computing applications.

Table 1. Additional Reviews of Instructional Computing Research

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Conclusion

What I often find to be the most valuable outcome of incorporating research topics in educational computing courses is the students' realization of how little common instructional computing teaching practice is rooted in research findings. This realization fosters a reflection upon how, in education in general, instructional practices often fail to have a supporting knowledge base or fail to reflect one if it exists. Such a consideration is not intended to devalue the importance of practical experience, intuition, expert judgement, and common sense in designing learning experiences. It provides the student with a broader perspective upon the scientific bases for what teachers do to and for students, with and without computers.

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RESEARCH

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Introduction

The research papers presented in this year's annual demonstrate that we continue to strive for a definitive knowledge base linking teacher education and technology. It is not surprising, therefore, that the studies presented in this section include a wide range of topics from educational practice to the content of professional textbooks. In organizing this section, we find that the papers fall into four subcategories of research. The categories include 1) a study that deals with research theory and methodology, 2) studies that investigate the attitude of the learner, 3) studies that investigate aspects of collaboration and technology, and 4) studies that are specific to the content of teacher education and technology.

Research Theory and Methodology

The first article in this section, *The Use of Classroom Observations in Technology and Education Research* by Copley and Williams (University of Houston), deals with the use of qualitative observational data in technology and education research. This paper reviews eight studies in which observational data were used.

Technology and Attitudes

Several papers in this section deal with the attitudes of learners toward technology. The first article in this section is *Preparing New Teachers to Use Technology: One Set of Perceptions* by Handler and Marshall (National-Lewis University). This papers investigates how programmatic aspects can result in significant differences in the preparedness students feel to use technology in their classrooms. In *Instructional Implications of Teacher Education Students' Attitudes Towards Using Computers,* Hunt and Bohlin (California State University, Fresno) demonstrate that preservice courses and inservices have a significant impact on how teacher education student attitudes develop.

The way in which students view equity issues is the focus of Padrón's paper, *Teacher Education Students' Attitudes Toward Equity Issues in Technology.* She is from the University of Houston-Clear Lake. The focus of the paper deals with the use of technology for male and female learners. The next study that deals with attitudes and technology is Woodrow's Programming and Attitudes Toward Computer Utilization (University of British Columbia). She found that programming could be included as an element of preservice computer training courses without risking the diminution of attitudes toward computer utilization.

The final papers in this section are by Huang, Copley, Williams, and Waxman of the University of Houston and by Beers, Orzech, and Parsons from State University of New York_College at Brockport. Huang et al. examined

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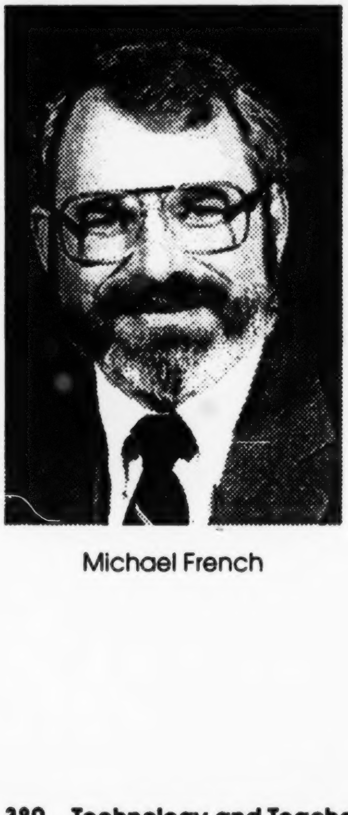
middle-school mathematics teachers' attitudes toward calculators. And finally, the Beers et al. paper is a progress report of ongoing research dealing with the attitudes of elementary teacher preparation students toward microcomputer use.

Technology in Collaborative Settings

The two studies in this sections detail investigations in which technology was used in collaborative teaching activities. The first is *Collaborative Writing and Electronic Feedback: An Evaluation of For Comment* by King, (Gallaudet University). The second is by Reicken, Francis, and Farragher (University of Victoria): *Collaborative Research: Using New Technologies in a Middle School Setting*. King's research dealt with using an application called *For Comment* in her research methods course at Gallaudet. Reicken et al. used *HyperCard* in collaborative activities in middle school settings.

Content Specific Studies

The final two studies focus on technology in specific areas of content. Watkin's paper deals with the integration of technology in mathematics and science, whereas Padrón's paper deals with the inclusion of technology in the content of pre-education textbooks.



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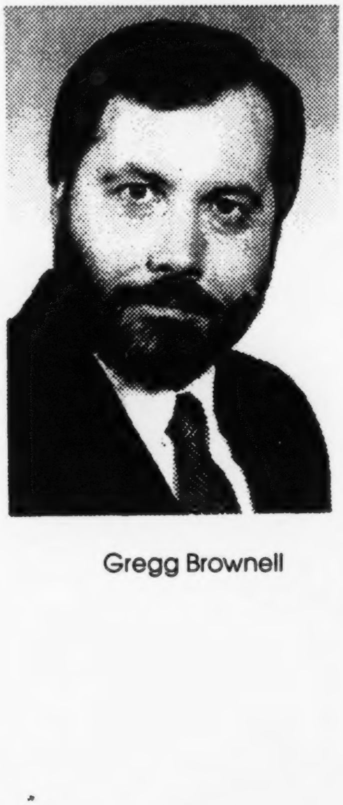

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The Use of Classroom Observations in Technology and Education Research

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Abstract

Systematic classroom observations provide rich, detailed descriptions of instructional events. Although the methodology necessary in the collection of observational data is labor-intensive and costly, the benefits of observational data in the research of technology use are numerous. The eight studies discussed in this paper use observational data to analyze the quality and the processes of technology use as well as the quantity and the products of technology use. The findings and additional questions that are generated from the collection and analysis of observational data produce strong evidence for the expanded use of this research technique.

Introduction

The integration of technology into existing curriculum and instructional practices has recently been advocated as the impetus for necessary reforms in teacher education programs. Combined with current research on learning and teaching, the use of technology seems to have potential for the educational community (David, 1990). Despite encouraging results in some educational arenas, however, the promise of technology as it is integrated into the teacher education program has not realized its full potential. Researchers and practitioners require a clearer description and understanding of models and methods of integration that work along with clarification regarding those that do not. Classroom observation is a research technique that can produce characteristically rich, detailed descriptions of instructional events (Berliner, 1986). The descriptions provided by the collection and analysis of observations of classrooms that integrate specific technologies into the educational process can lead to improved understanding and the testing of alternative solutions to problems.

The purpose of this paper is to present a case for the use of observational data in research on technology and teacher education. Reasons for the collection of observational data along with the inherent problems of its use will be discussed. Then, descriptions of eight research studies that use observational data will be presented along with their findings regarding technology and education. Finally, the future possibilities of observations to the research community and the understanding of technology's impact on education will be hypothesized.

Why Classroom Observations?

The methodology necessary in the collection of observational data is labor-intensive, time-consuming, costly, and usually requires some form of technology. The use of observational tools, especially tape-recordings or videotape technology, the training process necessary for reliable observers, the selection of the appropriate settings for the observations, and the specific types of coding systems to be used are some of the practical considerations involved in the collection of observational data. In addition, the pilot studies and field tests necessary for the development of reliable instrumentation contribute to the intensive time involved to collect and analyze observation data. So, why use classroom observations to collect data on the integration of technology and teacher education?

Quality, not just Quantity

The integration of technology and teacher education is more than just a physical change that can be described by counting the number of computers purchased by a school district or by submitting plans for the redesign of the classroom's physical layout. Recently, contemporary reformers have recommended the infusion of quantities of computers into schools, counted the number of technologies seemingly available to students and teachers, and concluded that the integration of technology into the educational system has occurred. Dwyer's (1991) study indicated that by researching the process of integration using only those indicators that are easy to count, investigators may have actually been researching the non-integration of technology into the classroom rather than the integration of technology.

Observational data allows researchers to examine the quality of the process of integration and not just the quantity. Systematic, question-specific observations of classrooms using technology, in collaboration with other forms of data collection, can help the researcher and practitioner focus on the qualitative aspects of technology use in classrooms as well as the quantitative ones. Research which uses classroom observations can be used to check the veracity of assumptions regarding educational reforms and well-integrated technology, the effects of innovative programs, and possibly avoid urging costly programs that, when properly examined, indicate ineffectiveness (Good & Biddle, 1988).

Process, not just Product

Technology has been claimed by some to be the answer to education (Cuban, 1986); however, the answer does not lie in the product features of the technology alone, but rather in the process of technological reform as it is used to create environments for learning. The history of education reform provides scant evidence that educational transformations will occur simply because the technology exists (David, 1990; Dede, 1990). The process of change along with the resulting products needs to be assessed.

Properly-designed, observational instruments utilized by trained observers can help identify some of those processes.

The process of education and the integration of technology is complex. The lack of observational findings often makes it easy for educators to misperceive problems and believe that complex issues can be defined simply. The collection of only product data with little or no observation data will not explain why a particular reform worked or did not work (Good & Biddle, 1988). With observational data, researchers can examine the processes involved in the effective use of technology and focus on the mediating variables that effect the outcomes. The rich data collected from observations provides a more illuminating understanding of classroom events and generates additional ideas and questions concerning teacher education in relation to technology (Shoenfield & Verban, 1988). The synthesis of product measures with the often complicated processes that occur during instruction can help provide a framework for research in the use of technology in educational settings and in teacher education.

Descriptions of Studies using Observational Data

Currently, the use of technology in educational settings has generally been researched using self-report, interview, and survey methods of data collection (Swadener & Jarrett, 1986; Woodrow, 1987). In addition, technology has been effectively used in many research studies to observe life in classrooms (Vanderbilt Cognition and Technology Group, 1990; Hoover, Mines, & Gagnon, 1991). In contrast to those methods, eight studies which used observational data to investigate the use of technology in educational settings produced some interesting, if not surprising, results.

Few studies employed observation techniques when studying technology use in classrooms before 1985. One of the earliest exceptions was Goodlad's study (1984), *A Place Called School*. Observers "found little use of calculators, computers.... " Goodlad concluded that the "technological revolution leaves schools virtually untouched" (Goodlad, 1984, pg. 340).

One study, "Patterns of Microcomputer Use" (Shavelson, et al., 1984) used systematic classroom observations in conjunction with teacher and administrator interviews. After selecting sixty teachers from 25 districts and 49 schools based on their nomination as "successful users of microcomputer-based mathematics and science instruction", researchers observed one class period for 50 minute segments per teacher. The systematic observation method used required researchers to map the physical layout of the room, identify activity structures in the classroom, time the amount of computer activity, and select and observe several students using software. Several checklists and rating scales were used. Collating the observation data along with data collected from the interview, four clusters for effective microcomputer use were identified: (1) orchestration and management, (2) enrichment, (3) adjunct instruction, and (4) drill and practice activities. In addition, and perhaps more importantly, researchers concluded that, due to the observational data, they found good reason for concern regarding social inequalities in computer-based instruction and lack of good instruction involving technology.

Two fifth-grade classes were observed systematically to experimentally determine the relationship between engagement and learning in different Logo learning environments and mastery. The observational system used, Stallings Observation System (SOS) (Stallings, 1983), requires that three independent observers observe a class three times during data collection. Categories of behaviors classify teacher and student interactions along with the time allotments. No observable differences were found between the two Logo environments. Researchers stated that the "quality of specific activities involving the microcomputer was not assessed with the traditional observations measure used." (Kinzer et al., 1985, p. 42) They further stated that to study the degree to which students use microcomputers, new observational instruments would be required (Kinzer et al., 1985).

In Shoenfield & Verban's (1988) study, they observed a definite shift toward more engaged students and an increase in the amount of individual attention a teacher gave students when a particular geometry tutorial was used. Using the "full field note" observational method which involves taking extensive handwritten notes during the events being observed, dictating on to audiotape, and then transcribing the results, researchers observed roughly 250 hours of instruction. While the results of the software package were promising for geometry instruction, observational data revealed other information about the school. To obtain comparative data about the geometry tutorial, over half of the 250 hours of observation were completed in classrooms that did not use the program. However, since administrative personnel had reported that the district had a computer based remedial math program, it was expected that observers would see computer use of software programs other than the geometry tutor. The findings indicated otherwise. Computers rarely, if ever, were used in teaching mathematics. Stated differently, the results of classroom observations and the self-reported use of technology by administrators in the school where the observations occurred produced conflicting results.

A study of the interaction at computers by language minority boys and girls paired with fluent English proficient peers used video-taped observations to conduct research. Interactions, on or off-task behaviors, and degrees of success were coded using a specially-developed questionnaire. Results indicated that regardless of gender, the pairing of students using technology can be an effective strategy in bilingual programs (Merino, et al., 1990).

Gender equity and technology use in middle school physical science classes was investigated using a combination of video-taped observations, interviews, and pre and post achievement tests in a study completed by Koontz (1991). Using an interactive coding system, the video-taped observations were analyzed for the frequency of gender-fair practice, namely, equally questioning of both males and females, ratio of asking girls to boys to use the computer, ratio of girls to boys being asked to set up and perform experiments, use of cooperative learning with equitably assigned roles, and the use of role models. Primarily because of the observational data collected, the results showed that teachers did not demonstrate fair equity practices in the use of technology, even though they were aware of those practices. In the analyzed observations, boys were always assigned the more technical role when teachers selected a student to demonstrate a concept using the computer technology

Carey (1991) compared the teacher behaviors in computing environments and regular classrooms. Using a Timeline Coding technique (Acheson & Gall, 1980), observers tallied the types of behaviors that occurred in both environments and then calculated the proportions of time spent during the observed class in each behavior category. The hypothesis that no significant difference existed between the computer-augmented or regular environments was supported by the results of this study.

The use of calculator technology has been a frequent focus in the research area of mathematics instruction. Often, when the effects of calculator usage are only reported from self-reported survey instruments, standardized tests, and attitudinal instruments, conflicting or non-conclusive results occur . A three year study examining the quality and quantity of calculator use of 7,000 middle-school students is currently in progress. As part of the data collection, sixty teachers are being observed systematically in four class periods per year. A modified version of the Classroom Rating Scale (Waxman, et. al., 1983) was used to measure the amount of calculator instruction that was observed in each classroom and to assess the quality of the calculator instruction. The inter-rater reliability for the instrument was greater than .90. This observation data in collaboration with other achievement and additudinal measures should provide some clarifying information describing the use of calculator technology.

Clearly, systematic observational data coupled with other measures would aid the understanding of technology use in classrooms. From a broader perspective, the success of mathematics programs (a content area where the use of technology is most often encouraged) needs to be evaluated by a wider range of measures than conventional testing (Hill, 1980).

Recommended Usages of Observational Research

The collection and analysis of observational data should be expanded to further investigate some questions that have already been analyzed using only outcomes. Additionally, new questions involving the process and quality of instruction with technology need to be answered using observational data.

Vanderbilt University is currently using technology to make systematic classroom observations of both novice and expert teachers (Vanderbilt Cognition and Technology Group, 1990). The tapes that are generated are then placed on interactive video systems and used by beginning teachers to make decisions regarding instruction and curriculum. Although not currently practiced, the methods used by the Vanderbilt University studies could certainly be used to observe the use of technology in classrooms.

Other kinds of research involving teacher education and technology use seem to be especially appropriate for observational techniques. Interactive coding systems need to be used to assess the relationship between teachers' presentations, students' attention, and technology use. Comparisons between expert and novice teachers who use technology effectively in their classrooms need to be analyzed from a variety of perspectives. The effectiveness of the use of technology to the development of particular concepts in content areas along with the instructional methods necessary to aid that development require investigation.

Systematic classroom observations of technology use do produce important insights regarding the integration of technology and teacher education. The questions generated as a result of the observations and the contributions to current research provided by the analysis of the observations make this type of research methodology especially relevant to technology and education.

Acknowledgements

This research was supported in part by a grant from the Department of Education, Eisenhower Funds, #R168D00311. The opinions and views expressed in this paper do not necessarily express the views of the granting agency.

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Preparing New Teachers to Use Technology: One Set of Perceptions

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Abstract

This project collected survey data in an attempt to describe the implications of the technology component of a preservice program. The paper focuses on programmatic aspects that result in significant differences in students who feel prepared to use technology and those who do not.

Introduction

Educational agencies and accrediting bodies, numerous professional organizations, researchers, scholars, and public policy persons all have noted the growing need to integrate computer technology throughout all facets of organized learning in this country (Allum, 1991; Bitter & Yohe, 1989; US Congress OTA, 1988;). Although 89% of all schools of education offer some opportunity for computer training to their students, only 29% of education majors responding to a national survey saw themselves as prepared to teach with computers (U. S. Congress, 1988). Criswell (1989) found a growing sense of failure of preservice education programs to prepare first-year teachers who feel confident about using computers in their classrooms. It seems, in short, that even those who work to infuse technology awareness into preservice teacher education can claim little success. Examination of current efforts may help to illuminate this persistent problem.

Methodology and Data Analysis

In this study we examined the perceptions of preservice teacher education program graduates at one university. One hundred and thirty-three teachers (n=133) responded to the survey designed to collect their perceptions of the purpose of intentional preservice computer experiences , the value of these experiences to graduates' professional preparation, and the ways in which they are currently using computers in their classrooms. The preservice students in this study ranged in age from 22 to 61 and completed either elementary or early childhood preservice programs at both the graduate and undergraduate levels.

A Likert-type survey sent to preservice program graduates collected both qualitative and quantitative data. Statistical analyses were used on Likert items to group respondents and compare these groups. Qualitative responses were grouped according to emerging themes and common threads regarding additional skills the graduates felt were needed and recommendations they would make to other beginning teachers.

All data were analyzed in light of two respondent groups: teachers who reported that their program resulted in their feeling prepared to use computers in their teaching and those who were not. Teachers were asked to respond to this question along a 7 point scale. Those who responded with a value equal to or greater than 5 were placed in the feeling prepared group. Within the total group of respondents (n=133) 18.8% indicated that they felt prepared by their program to use computers for instruction. Further analysis showed that within the undergraduate population, 22.7% felt prepared as opposed to 14.3% among those receiving a graduate degree. Those identified as feeling prepared included new teachers from each of the previously mentioned programs and from both the graduate and undergraduate levels. They ranged in age from 22 to 43, with the majority clustered between 22 and 35 years of age.

Significant Factors in Feeling Prepared

An introductory computer course

We asked questions within the survey that allowed for examination of the value of the introductory course required for all undergraduate students and available to graduate students as an elective. We analyzed the survey responses to determine if taking this course had made a difference between students who felt prepared to use computers for instruction and those who did not.

We asked respondents to indicate if they felt prepared by their program to use the computer in their instruction. We then wanted to see if there was an overall difference in 'feeling prepared' between those respondents who had taken the introductory course and those who had not. Taking the introductory course did account for students feeling more positive about their preparation. The mean ratings for those who took the course (3.8) and for those who did not take the course (2.7), showed significance (t= -3.0, p <.001) .

Additionally, we looked specifically at a unique group of those who identified themselves as feeling prepared to use technology in the classroom. This group included respondent who rated themselves at the lower end (1-4) of a scale measuring their comfort level with computer use **prior** to taking the course offered in the program. All respondents falling into this category, and feeling prepared today, had taken the "Introduction to Using Computers in Education" course. It is clear that the introductory course was valuable for those who had not had prior experience with computers.

Use of technology in methods courses

Teachers were asked to identify any methods courses in which technology had been used, and then to describe how it was used. For the purpose of this comparison all students who indicated any use of technology in their methods course were counted as a 'yes' response and those who did not were considered a 'no.' Among all of the respondents, the most commonly noted use of the computer within any methods courses was to use the word processor for completing assignments. The second most common response indicated having had an experience in software evaluation. In their descriptions of the ways in which the computer was used in their classes there was infrequent mention of it being used directly for instruction.

The use of computers, in some way, has an impact in the preservice teacher developing a sense of feeling prepared to use computers for instruction. The Chi Square test of independence found significance (p=.0134) in comparing students who had seen computers used in their methods classes and those who had not. Those teachers who indicated that they felt prepared to use computers were also those who had most frequently seen the computer used in their own class experiences. The importance of modeling those strategies we hope our students will use in their own teaching is reaffirmed by these findings.

Preclinical and student teaching experiences

Preclinical experiences cover all experiences in classrooms prior to beginning student teaching. Students in each of the programs, at both levels, participate in at least 100 hours of preclinical experiences before their student teaching experience. Each of these program aspects, preclinical and student teaching experiences, was divided into two separate segments: observing and participating in the use of the computer. We found no significant difference existing between those students who felt prepared and those who did not in terms of either their observation of or participation in computer use during their preclinical experiences.

However, the student teaching experience appears to play a strong role in the new graduates' sense of being prepared to use the computer for instruction. We did find a significant difference between students who felt prepared and those who did not in the impact of both observing (t = 3.10, p = .004) and participating in computer use (t = 2.4, p = .02) during the student teaching experience.

Impressions in the work place

The sense of feeling prepared through one's program to use computers in the instructional process appears to also impact on the degree to which new teachers actually use the computers in their classrooms. Here, we noted a significant difference in the mean of the frequency with which teachers who felt prepared and unprepared now use classroom computers (t= 2.2, p = .042). Furthermore, those who felt prepared also felt significantly more ready to take a leadership role in the area of technology use in their schools (t = 2.9, p = .008).

Finally, we asked respondents to indicate additional skills they felt would be important to bring to a first teaching job. Their comments fell into several categories:

information about hardware; information about software; areas in which the teachers felt they needed to learn more themselves; and their need to become more familiar with instructional strategies for using computers in instruction. Responses ranged from feeling the teacher should know how to turn on the computer and put in a disk as a primary step, to the feeling that they do not need to have personal knowledge if there is a computer teacher in the school. Frequent responses spoke to the need for becoming familiar with the computer for personal use and of the importance of finding time to practice and to preview software. A group of respondents spoke to the need to know how to make use of personal applications such as word processing programs and teacher gradebooks. This was not a surprise given our finding of significance in the comparison of teachers who felt prepared and their rating of themselves as personal users of computers.

Other responses indicated that teachers wanted a clearer picture of how to incorporate a one-computer or two-computer classroom into regular whole-class instruction, how to teach using a computer, and ways in which the computer can be integrated into the various subject areas.

Conclusions

Findings from this study suggest that university-based curriculum courses designed to enhance preservice teachers' ability to feel prepared to use technology in their classrooms may not be sufficient. Although a single course introducing teachers to technology use in education is very important for some, it is not enough for most preservice teachers. Equal attention, it appears, should be given to the technological climates in which students develop "hands on" and "minds on" preclinical and student teaching experiences.

Given the shrinking number of professional courses found in most teacher education programs the responsibility for providing this much needed instruction falls to all of the faculty in such programs to model appropriate use of technology as an instructional tool. This may mean the reexamination of course syllabi to provide both hands-on experiences during class and assignments as well as modeling computer use for direct instruction.

While the impact of one specific, technology-oriented course was important for those students who had not had prior computer experience, the importance of modeling technology use in classrooms by university faculty must not be overlooked. Additionally, those involved in the student teaching placement should seek classrooms where technology is used as a matter of routine by veteran teachers. Modeling of this sort, it seems, leaves lasting positive impressions.

The perceptions of these new teachers in our study points out the importance of examining all of the experiences with technology we provide within our preservice programs. Further study might examine the specific ways in which students gain the sense of preparedness in classrooms, or look at university - school efforts to provide technology experiences beyond initial teacher preparation. Whatever directions are taken, existing preservice programs must continue to participate in ongoing self-evaluation to maintain their excellence, and the aspect of technology must not be ignored during such examination.

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Instructional Implications of Teacher Education Students' Attitudes Towards Using Computers

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Abstract

Computer-oriented courses or inservice experiences for teachers must be taught in a manner that recognizes entry attitudes and previous experiences, reduces anxiety, and increases the likelihood that participants will use computers in their instructional program. This study reports on a survey of students entering educational computing courses and relates some implications these findings have for teacher educators.

Key findings included that students enter these courses with a wide range of experience using various computer applications and that previous experience using computers is the best predictor of student attitudes. Of particular importance to teacher educators, these students generally reported that ability to use computers was a useful skill for living in today's society; however, they did not consider computer expertise as being an important part of a teacher's job nor could they think of any way that computers could be used in classrooms.

Introduction

Since the early 1980's, school districts have invested heavily in microcomputer-based technologies (Bruder, 1989). Research has shown, however, that half of all classroom teachers do not use computers within their instructional program (OTA, 1988, p. 87). Two major factors in this situation are teacher fears and a lack of understanding of the computer's potential value as an instructional aid. Significant numbers of these teachers can be termed "computer-anxious." This anxiety interferes with their ability to integrate technology in their classroom teaching.

Many states are addressing this problem by recommending, or requiring, that teachers receive preservice or inservice instruction on using computers in the classroom. As anxiety interferes with learning, it is important that teacher educators be sensitive to any initial student fears and teach in a manner that reduces computer anxiety and increases student confidence and likelihood of using computers in their classrooms.

The purposes of this study were to determine:

a) the entry attitudes towards using computers of students enrolling in educational computing courses for classroom teachers; and
b) the implications these findings have for teacher educators.

Methodology

Faculty from four California State University campuses participated in this study during the spring, summer, and fall semesters of 1991. The professors distributed the research instrument to their students during the first week of class. Data were gathered from a total of 518 students: 394 were female, 108 were male, and 16 did not report their sex. Participants' ages ranged from 20 to 60. The mean age was 32.2, with a standard deviation of 8.3.

The instrument included Loyd and Gressard's (1985) 40-item *Computer Attitude Scale* (CAS), a request for minimal demographic data, and five questions about the student's previous experience using computers. The CAS is composed of four subscales: "Computer Anxiety," "Computer Confidence," "Liking Computer", and "Usefulness of Computers." The ten items on each of the subscales asked students to indicate the extent to which they agree or disagree with statements that refer to anxiety towards using computers, confidence in their ability to use computers, whether they like using computers, and their perceptions of computer usefulness. Subscale scores can range from a low of 10 to a high of 40; 25 is considered a neutral score.

Loyd & Loyd conducted a reliability and validity study on the CAS using a group of 114 teachers enrolled in an educational computing course. They report reliability coefficients for internal consistency to be .90, .89, .89, and .82 for the respective subscales. They found a very strong correlation (.92) between the anxiety and confidence subscale scores, which they interpret to mean that these subscales may be measuring the same trait. Correlations among the other subscales were also strong, but varied enough to be interpreted as measures of separate characteristics (Loyd & Loyd, 1985).

Findings

As reported in Table 1, mean scores for student anxiety, confidence, liking, and usefulness were 18.490 (sd 6.847), 31.701 (sd 5.780), 30.909 (sd 6.061), and 35.160 (sd 4.066). These scores indicate that the students disagreed slightly with items associated with high anxiety, low confidence, low liking, and low perceptions of computer usefulness. These mean scores are comparable to those Loyd & Loyd (1985) found for a similar teacher population.

Table 1 Mean Scores and Percentages of Students Indicating Low Levels of Anxiety and Confidence, Liking, and Usefulness ($N = 518$)

	Mean	*Std Dev*	*Scores < 25*
Anxiety	18.490*	6.847	79.2%
Confidence	31.701	5.780	13.4%
Liking	30.909	6.061	16.5%
Usefulness	35.160	4.066	2.5%

* Please note that in order to counteract a high score meaning a low level of anxiety, the researchers reversed the directionality of this subscale. Using Loyd's scoring rubric, the mean anxiety score would be 31.510.

Responses to individual items that are especially significant for teacher educators were also studied. These items, given in Table 2 below, relate to feelings about being in a computer class and attitudes toward using computers in their future classrooms. Most of the students expressed some anxiety about taking a computer class, but nearly all (96%) agreed that it was important to them that they do well in such classes. Sixty-nine percent indicated that they would need a "firm mastery of computers for my future work" and nearly all (96%) thought that such proficiency would help them find jobs. However, eighty-eight percent did not think computers would actually be useful to them in their chosen work and almost none (96%) could think of any way they might use computers in their teaching career.

Table 2
Frequencies of Student Responses on Selected Statements (N=516)

Statement	Strongly Agree	Slightly Agree	Slightly Disagree	Strongly Disagree
1. (take classes)	31	88	147	250
2. (ease in class)	29	98	180	211
3. (do well in class)	365	128	16	7
4. (need to master)	147	209	125	35
5. (job prospects)	341	125	32	18
6. (not use in career)	432	64	14	4
7. (impt. in work)	319	134	31	21

Statements:

1. It wouldn't bother me at all to take computer courses.
2. I would feel at ease in a computer class.
3. It is important to me to do well in computer classes.
4. I'll need a firm mastery of computers for my future work.
5. Knowing how to work with computers will increase my job possibilities.
6. I can't think of any way that I will use computers in my career.
7. Working with computers will not be important to me in my life's work.

In an attempt to gather data on the level of student experience using computers, students were asked to self-report how many times (0, 1-10, 11-20, 21-30, or >30) they had used a computer for wordprocessing, programming, spreadsheet analysis, database analysis, and recreation. As shown in Table 3, students reported having many more experiences using computers for wordprocessing than for programming, spreadsheets, or database analysis. The students were most evenly divided on their reports of previous experiences using computers for recreational purposes. Please note that the instances of “No Report” reflect the fact that these questions were on the back side of a page and approximately 60 students did not see them.

Table 3 Frequencies of Students' Previous Computer Experiences ($N = 518$)

Application	Never	1-10	11-20	21-30	> 30	No Report
Wordprocessing	95	99	46	39	179	60
Programming	248	120	30	20	40	60
Spreadsheets	317	96	15	6	24	60
Databases	316	86	16	12	26	62
Recreation	100	140	64	41	108	65

A correlational analysis was conducted among all the variables. As shown in Table 4, there were numerous significant correlations found among the subscale scores and reports of previous computer experience.

Differences among subgroups

To determine if there were any significant differences between gender and age groups, a descending stepwise multiple regression analysis was run on each of the four subscale scores. The variables “sex and “age” did not contribute enough variance in the subscales to be included in the regression equations; indicating there were no significant differences ($p < .05$) between these groups.

It should be noted, however, that an earlier study done with a subgroup of 347 of these students (only those enrolled in spring and summer, 1991 classes) did find significant differences on two of the subscales. Women reported computers as being more useful than did men and older students agreed more strongly on those items that expressed computer anxiety. With these exceptions, the students' subscale scores did not differ significantly ($p < .05$) when grouped by sex or age.

Regression analyses did find significant differences ($p < .01$) when grouping students by their past computer experiences. Approximately 30% of the variance in the Anxiety and Confidence subscales was shared by students' previous experience with wordprocessing, recreation, programming, and database applications. Smaller amounts of the variance in usefulness and liking subscale scores could be predicted by computer experience. Ten percent of the variance in Usefulness scores was shared by wordprocessing, recreation, programming, and database experience; and 14% of the variance in the Liking subscale was shared by recreation, programming, and spreadsheet experience.

Key findings

- Most students agree that computers are useful tools for life in society today, but about 17% students disliked interacting with computers.
- While computer anxiety and confidence in their ability to use computers were not problems for a majority of the students, approximately 20% did indicate relatively high levels of anxiety and 13% expressed a lack of confidence toward using computers.
- Students entering these introductory computing classes came with a wide range of background knowledge and experience using various computer applications.
- The greatest differences among student scores on each of the subscales were found when grouping students based upon the type and frequency of their previous computing experiences.
- Students generally thought learning to use computers would be a useful skill for them, but most could not think of any way that they could use computers in their teaching career.

Table 4 Correlation Matrix

	Sex	Age	Anx	Conf	Liking	Useful	WP	Prog	SS	DB	Rec
Sex	1.000										
Age	.020	1.000									
Anxiety	-.082	.109*	1.000								
Confidence	.063	-.096*	-.880*	1.000							
Liking	-.005	-.073	-.684*	.741*	1.000						
Useful	.006	-.109*	-.523*	.599*	.697*	1.000					
Wordprocessing	.023	-.151*	-.500*	.434*	.273*	.259*	1.000				
Programming	.185*	-.158*	-.359*	.403*	.274*	.232*	.420*	1.000			
Spreadsheet	.067	.001	-.321*	.316*	.268*	.186*	.398*	.466*	1.000		
Database	.058	-.078	-.273*	.264*	.193*	.188*	.292*	.357*	.556*	1.000	
Recreation	.144*	-.180*	-.420*	.435*	.300*	.239*	.449*	.342*	.249*	.166*	1.000

* $p < .05$

Instructional Implications

- As evidenced by the high percentage of students who see computing skills as being useful, there is little need to rationalize the existence of computing classes in teacher preparation programs. However, students are not aware of the potential value of using computers in K-12 classrooms. Though this is troubling, it should not be too surprising when one considers that most of the students enrolled in teacher education classes today have never seen computers being used in classrooms to attain general curricular objectives. Thus, it is imperative that in addition to teaching students basic computer skills, computer classes for teacher education students must emphasize the transfer of those skills into K-12 practice. For example, instructors may have students practice using wordprocessing applications by having them create lesson plan templates and mock letters to parents.
- Though the study did not address hypermedia applications or adaptive devices per se, it can be assumed that few students have had hands-on experience with these technologies. Therefore, students' awareness of the potential for educational computing may need to be broadened to include advanced computer-based technologies and applications as well as the use of technology with special populations.
- The frequency and type of computer experience were the strongest predictors of student attitudes toward using computers. To promote students' view of the usefulness of computers in their lives, instructors should assign activities that are meaningful to the students' experience.
- Instructors must be sensitive to the fact that a significant number of students are going to feel anxious about using computers. Instructors must establish a nurturing environment in which students feel free to ask questions, make mistakes, and assist each other.
- Finally, as a significant number of the students expressed a dislike for working with computers, instructors need to develop strategies that the students will find enjoyable. Cooperative activities which require the students to interact within small groups often will enliven the classroom atmosphere as well as promote more learning than will individualistic assignments.

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Teacher Education Students' Attitudes Toward Equity Issues in Technology

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Abstract

This study examined teacher education students' attitudes towards the use of technology for male and female students and for students of various ability levels. The findings revealed than students' attitudes towards computers pertaining to gender and ability differences were similar and generally very positive.

Introduction

The integration of technology in the classroom is generally viewed as an effective instructional strategy, but others have found that the implementation of technology has resulted in increasing education inequities and discriminatory practices among different groups of students (Apple, 1988). These inequities include gender inequities, socioeconomic inequities, and racial inequities (Campbell, 1984). For example, ethnic minority and female students and students from low income backgrounds are less likely to have access to computers than non©minority, middle income, and male students (Cummins & Sayers, 1990, Dunkel, 1990). Educators are especially concerned about this issue because they fear that computers in schools will widen gaps between lower-achieving and higher-achieving students (Johnson & Maddux, 1991).

One explanation why these inequities may exist may have to do with teachers' misconceptions and stereotypical views of students' capabilities (Stallings & McCarthy, 1990). If technology is to be incorporated in the schools, it should be done so that it improves programs rather than maintain the past inequities in the educational system. In order to prevent these inequities, students in teacher education programs should be given the opportunity to understand the potential for misuses of technology (Apple, 1988).

The purpose of the present study was to identify teacher education students' attitudes towards the use of technology for students of various ability levels. The study also assessed teacher education students' attitudes regarding differences of the use of technology for males and females. More specifically, the study investigated if there were differences in students' attitudes in terms of the use of computers by male and female students or by high, average, and low ability students.

Method

Subjects

The subjects for this study were 109 teacher education students. There were 97 (89%) female and 12 (11%) male students . The ethnic backgrounds of the subjects were as follows: (a) White (74.1%), (b) Hispanic (16.7%), (c) Black (7.4%), and (d) Other (1.8%). The majority of the students (77.7%) had a GPA of 3.0 or above. Subjects were predominantly undergraduates

(77%) and all attended an upper-division university with an enrollment of approximately 7,000 students. The university is situated near the outskirts of a large metropolitan city in the south central region of the United States. The amount of computer experiences for the students was as follows: 60.2% have used computers for 2 or more years; while 2.8% have never used a computer. In addition, 12% have used the computer for less than 3 months; 9.3% have used it for from 6 to 12 months; and 15.7% had been using computers from one to two years.

Instruments

Two questionnaires, *The Computer Scale* (Violato, Marini, & Hunter, 1989) and *The Educational Technology Survey* (Waxman, Hwang, & Padrón, 1991), were used in the present study. The *Teacher Computer Attitude Scale* is a modified version of the *Computer Attitudes Scale* (Richards, Johnson, & Johnson, 1986) that has been validated with undergraduate students in education. For purposes of the present study, only the five items from the Sex Differences Factor are included. The *Educational Technology Survey* was developed specifically for the present study. The survey identify types and amounts of technology experiences. In addition, the survey assesses education students' attitudes toward the use of technology for students from different achievement levels. The instrument also assesses subjects' attitudes regarding difference of the use of technology by gender. All the subjects responded on a five-point Likert scale from "Strongly Agree" to "Strongly Disagree" for each of the items of the survey. All subjects participated voluntarily and both instruments were group administered during a class periods by their regular professor. The completion of the survey took approximately 15 minutes.

Results

Overall, teacher education students felt that ability and gender have little to do with whether a student is able to learn about the computer or enjoys working with computers. In the five items that measure gender differences, an overwhelming number (94.4%) of students either strongly disagreed (77.6%) or disagreed (16.8%) that using a computer was more difficult for females than for males. The results were similar for the item that asked students if males had more ability for become computer scientists than females. Sixty percent of the students responding to

Table 1
Summary of Results

Sex Differences	*SD*	*D*	*N*	*A*	*SA*
Using a computer is more important for males than females	77.6	16.8	4.7	0.0	0.9
More men than women have the ability to become computer scientists	67.0	23.9	7.3	1.8	
Using computers is more enjoyable for males than females	57.0	29.0	11.2	2.8	
Females can do just as well as males in learning about computers	0.9	1.9	2.8	36.1	58.3
Working with computers is more difficult for males than females	57.8	29.4	11.0	1.8	0.0
Achievement Differences					
Working with computers is more difficult for lower-achieving students than higher achieving students	39.4	36.7	17.4	4.6	1.8
Working with computers is more difficult for average achieving students than high achieving students	34.9	46.8	14.7	2.8	0.9
Using computers is more enjoyable for higher achieving students than lower-achieving students	43.1	33.9	16.5	6.4	0.0
Lower achieving students can do just as well as high-achieving students in learning about computers	3.7	5.6	8.3	42.6	39.8
Using a computer is more important for higher achieving students than lower-achieving students	55.0	33.0	11.0	0.0	0.9

Key:
SD=Strongly Disagree
D=Disagree,
N=Neither Agree or Disagree
A=Agree
SA=Strongly Agree

this item indicated that they strongly disagreed with the statement; while and additionally 23.9% disagreed with the statement.

Although, the percentages are still over the 50% range for the next three items, the percentages are smaller for the strongly disagree category. For example, when students were asked to indicate whether males enjoyed working with computers more than females; 57.0% strongly disagreed and 29% disagreed. The same pattern is found for the next items stating that males found it more difficult to work with computers (57.8% strongly disagreed and 29.3% disagreed). In addition, students strongly agreed that learning about computers was no more difficult for females than for males (Strongly Agree: 58.3%; Agree: 36.1%).

For the differences in abilities, similar positive results were found. Students strongly disagreed (55%) or disagreed (33%) that the use of computers is more important for higher-achieving students than for lower-achieving students. The subjects in this study also either strongly disagreed or disagreed that the use of computers is more difficult for lower (76%) or average ability (81.7%) students than for high ability students. Furthermore, comparable results were found in terms of whether computers were more enjoyable for high-achieving students. Seventy-seven percent of the teacher education students either disagreed or strongly disagreed with the statement. In addition, 82.4% of the students responding to this survey indicated that lower-achieving students can do just as well as high-achieving students in learning about computers.

Conclusions

The results from the present study revealed that these teacher education students generally had positive attitudes about the use of technology both for male and female students as well as for students of differing ability levels. The study indicated that teacher education students did not view computing as a male realm. Similarly, students did not see the use of computers for only high-achieving students. Students did not see ability level as an issue in terms of students being able to learn about using computers and to enjoy the use of computers. Future studies need to examine if these attitudes persist once most of these prospective and relatively inexperienced teachers gain more experience. Other studies also need to investigate whether experience veteran teachers hold similar attitudes. If further studies support the present findings, then additional studies may need to investigate other plausible hypotheses that may explain if, how and/or why technology may increase educational inequities.

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Programming and Attitudes Toward Computer Utilization

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Abstract

Five attitude dimensions were used to examine the effect of an emphasis on programming in an elective computer training course for preservice teachers to determine whether there would be any general improvement in their attitudes towards the utilization of computers. The subjects were thirty-six, computer novice, preservice teachers. The results of the study indicate that positive attitude improvements were achieved. It is the conclusion of this study that programming could be included as an element of preservice computer training courses without risking the diminution of attitudes toward computer utilization.

Introduction

Computer training courses for educators must strike a fine balance between developing computing skills and encouraging positive attitudes toward computer utilization. Knowledge of the fundamentals of programming a computer and being able to read and write simple computer programs are frequently cited as components of computer literacy for teachers. However, in an effort to promote positive attitudes, computer training courses frequently de-emphasize or omit programming skills. But how valid is the assumption that the inclusion of programming skills will negatively affect computer attitudes? This paper describes the results of a study that investigated the development of programming skills and the development of attitudes toward computers. Its purpose is to increase computer educators' insight into the possible outcomes of computer training courses for preservice teachers.

Review of The Literature

The appropriate content of computer training courses for teachers is currently beset with numerous problems (Troyer, 1988). Fundamental to this problem is the lack of consensus as to what specific skills and competencies are needed by teachers. Embedded within many definitions of computer literacy is the expectation that computer literate teachers will have fairly proficient programming skills. For example, Anderson and Klassen (1981) claimed that one would not really know what is going on with a computer unless one knows how to program. However, this view is far from being universal. Other authors suggest that only a general understanding of the rudiments of programming is a requisite to computer literacy. A third group contends that teachers need no knowledge of programming at all. Members of this group believe that teacher computer literacy training should prepare teachers to consider methods of utilizing the computer effectively in the classroom, to evaluate available software, to use the computer as a tool in accomplishing record keeping and managerial tasks, and to consider the larger impact of computer technology on society and education. However, a review of the literature leads to the conclusion that the majority of curriculum designers continue to recommend that teachers be given *some* understanding of how one communicates with computers through programming. It is important, therefore, that curriculum designers have some understanding of the possible effects of such programming training.

Among the reasons advanced for eliminating programming from introductory computer training courses for teachers is the belief that an emphasis on programming will not result in a positive increase in teachers' attitudes toward computer utilization nor significantly increase their level of computer literacy and commitment to the classroom use of computers. The importance of promoting favorable attitudes toward computer utilization is reflected in many definitions of computer literacy. Simonson, Maurer, Montag-Torardi, and Whitaker (1987) for example, state that "a positive, anxiety-free attitude toward computing [is] a necessary prerequisite of computer literacy" (p 233). Griswold (1983) noted that "negative teacher attitudes promote a resistance to learning about computers and influence the acceptance and use of technology in the classroom" (p 93). Similarly, Reece and Gable (1982) argued that introducing microcomputers into schools will be a waste of time and money if the training curricula do not support the development of positive attitudes toward computers. It is important, therefore, that computer literacy courses not diminish teachers' positive attitudes toward computer utilization, but, if possible, enhance them while at the same time expanding teachers' computer literacy. It is also important that computer training courses for teachers be designed to foster an attitude of commitment to actually implement computer applications in the classroom.

The Study

A pretest/posttest study was conducted to determine whether or not an emphasis on programming in a computer training course for preservice teachers would result in an increase in the students' attitudes toward computer utilization and their levels of computer literacy. The goal of the course was to provide the preservice teachers with basic programming skills as a means of promoting the utilization of the computer for educational purposes. In this study, it was hypothesized that the "hands-on" format adopted for instructional purposes and the stress on practical educational applications to illustrate programming techniques would combine with the acquisition of programming skills to enhance the students' attitudes toward computers. The results of the study indicate that this goal was achieved.

The subjects used for the study were 36 (24 female and 12 male) preservice teachers enrolled in two sections of an elective, computer training course for computer novices. The course had no pre-requisites but was a prerequisite to all further courses offered by the department in computer studies. The course curriculum included seven of the ten most frequently recommended topics for teacher computer literacy training: computer operation and structure, educational applications of computers, software evaluation, word processing, elements of programming, familiarity with a range of software and programming in BASIC. (Troyer, 1988).

A comprehensive questionnaire containing four attitude scales (Woodrow, 1991) and the cognitive scale of the Minnesota Computer Literacy and Awareness Assessment (MCLAA), (Anderson, Hansen, Johnson & Klassen, 1979) was administered to the 36 students during the first and final meetings of the classes. The first administration of the questionnaire was also used to collect data on four of the independent variables used in the study: age, gender, prior programming experience, and prior word processing experience. The final grade achieved in the course was the fifth independent variable

Analysis

The pretest and posttest data was used to determine changes in computer literacy and attitudes toward computer utilization among the 36 participants in the study and to determine the student attributes to which these changes were correlated. The four attitude scales were purported to contain a total of six different dimensions. However, a factor analysis detected the presence of only five principle attitude dimensions among the attitude scales. These dimensions were identified as Computer Anxiety (20 items), Computer Liking (20 items), Social and Educational Impact of Computers (Computer Impact - 10 items), Computer Acceptance (10 items) and Benefits of Computer Use (Computer Benefits - 10 items). The items related to the Computer Anxiety dimension were scored in a manner that gave a high numerical score to those with a low level of anxiety to retain mathematical consistency with the other four scales. These five attitude dimensions, the combined measure, the Computer Attitude Index, and the Computer Literacy score from the MCLAA test, constituted the dependent variables used in the study.

Pearson product-moment coefficients were computed to test for correlations among the independent variables and the entry levels of the computer attitude dimensions and computer literacy. Means and standard deviations of the pretest and posttest measures of the dependent variables were computed; differences between means were analyzed by use of a *t* test for correlated samples. Correlations between gains in the dependent variables and the independent variables were then examined. An analysis of covariance analysis was used to statistically control initial differences in attitudes toward computers and computer literacy among the students upon entering the course. The five Computer Attitude dimensions and the measure of computer literacy were each individually analyzed using a one-way analysis of covariance procedure with the appropriate pretest scores as the covariate and the five student characteristics as the independent variables. As a follow-up to the covariate analyses, the Tukey/Kramer post hoc multiple comparison test was used to determine which group means differed significantly whenever a significant *F* ratio was obtained.

Results

Correlations with Student Attributes

There was no indication of any gender correlations with any of the entry level attitude dimensions nor the entry level of the subjects' computer literacy. Correlations with age were similarly absent. Correlations among the other entry level student attributes and the final grade achieved in the course are summarized in Table 1. Of the five attitude dimensions included in the study, four, - Anxiety, Impact, Acceptance and Benefits, were significantly correlated with each other. Of these four dimensions, those of Anxiety and Benefits were correlated with prior word processing experience at the $p < 0.05$ level, while the other two, Impact and Acceptance, were correlated with prior word processing experience at just below this level. The computer attitude dimension of Liking exhibited no significant correlations with the other four attitude dimensions nor with prior word processing experience. However, Computer Liking was significantly correlated, at the $p < 0.05$ level, with the entry level of computer literacy. In this respect, Computer Liking behaved in a manner similar to that of Computer Impact and Computer Benefits which were also significantly correlated with computer literacy, albeit at the $p<0.01$.

The other significant correlations shown in Table 1 are between the final grade achieved in the course and both prior programming experience and entry level computer literacy, and between prior programming experience and computer literacy. One aspect of the data summarized in Table 1 that warrants comment is the lack of a significant correlation between Computer Anxiety and computer literacy. On the chance that this result may have been influenced by the relative lack of computer experience and computer literacy of the subjects, the posttest data was also analyzed for correlations but yielded results similar to those shown in Table 1. These results are somewhat surprising given the fact that to many, a positive attitude toward computers is a necessary prerequisite to computer literacy (Simonson, et al., 1987).

Attitudes

The pretest/posttest results summarized in Table 2 indicate that the students generally felt positive about their learning experiences in the programming-oriented computer training course. The attitude dimensions of Liking, Impact and Acceptance, as well as the composite Computer Attitude Index, all increased significantly, at the $p<0.01$ level, over the instructional period. Countering these gains was the fact that the reduction in the subjects' level of anxiety did not reach the level of significance. However, the subjects did enter the course with relatively low levels of anxiety (mean = 75.7 out of a possible 100) so it is perhaps significant that the emphasis on the development of programming skills in the course did not negatively affect the subjects' level of anxiety. The Benefits dimension behaved uniquely in that it exhibited a significant loss, at the $p<0.01$ level, over the duration of the course. Aside from the exclusive use of educational examples to illustrate programming techniques, the course did not focus on the educational applications of computers. The students entered the course with somewhat unrealistically high expectations of the immediate application and benefits of computers for the classroom.

Table 1
Correlations Among the Final Course Grade and Entry-Level Student Characteristics

	Word Proc	*Prog. Exp*	*Anxiety*	*Liking*	*Impact*	*Accept-ance*	*Benefits*	*Computer Literacy*
Grade	0.296	0.477**	0.001	0.171	0.211	-0.143	0.137	0.47**
Word Proc.		0.181	0.533**	0.001	0.303	0.311	0.38.*	0.287
Prog Exp.			0.098	0.208	0.210	-0.218	0.148	0.558**
Anxiety				-0.180	0.498**	0.521**	0.680**	0.241
Liking					-0.072	-0.143	0.057	0.344*
Impact						0.383*	0.642**	0.572**
Acceptance							0.342*	-0.035
Benefits								0.500**

Note. * $p < 0.05$, ** $p<0.01$

The reduction in this dimension reflects a perhaps more informed and realistic assessment of the present state of educational computing.

Table 2 *t* Test for Pretest and Posttest Measures of Computer Attitude and Computer Literacy Attributes

	Pretest		Posttest		
Attributes	M	SD	M	SD	*t*
Anxiety	75.7	10.5	77.5	11.0	0.93
Liking	57.1	20.3	76.3	9.7	5.4**
Impact	37.2	3.7	38.7	3.8	3.1**
Acceptance	29.6	7.1	36.2	2.9	5.3**
Benefits	41.9	4.3	35.9	4.4	5.4**
Attitude Index	241.5	26.9	264.6	24.8	4.3**
Computer Literacy	29.3	6.1	32.6	5.4	3.55**

Note. ** $p<0.01$

Literacy

The gain in the subjects' level of computer literacy, as measured by the cognitive portion of the MCLAA test was significant at the $p < 0.01$ level indicating that the course was successful at promoting computer literacy as defined by the MCLAA test.

Course Achievement

Table 3 summarizes the results of the covariance analyses in which the final grade achieved in the course was used as the independent variable. For the purposes of the covariance analysis, the 36 subjects were divided into three groups based upon the final grade achieved in the course. Group 1, (11 subjects) achieved grades < 65%, group 2, (11 subjects) achieved grades from 65% to 79%, and group 3 (14 students) achieved grades > 79%. The gains in the Anxiety and Liking attitude dimensions, as well as those of the composite Computer Attitude Index and Computer Literacy, were all found to be correlated with course achievement. The post hoc Tukey/Kramer test indicated that all the significant differences were between the lowest achieving group, and the intermediate and highest achieving groups. The differences between the intermediate and highest achieving groups were consistently very small and not statistically significant. Of the remaining covariate analyses, using age, gender, prior word processing experience and prior programming experience as the independent variables, none yielded significant results.

Table 3
Analysis of Covariance of Attitudes Toward Computers and Computer Literacy with the Final Grade Achieved in the Course.

Dimension	Source of Variation	Mean Squares	F (df=2/32)
Anxiety	Between groups	309.2	3.15*
	Within groups	98.9	
Liking	Between groups	329.8	3.92*
	Within groups	84.2	
Impact	Between groups	5.6	0.76
	Within groups	7.5	
Acceptance	Between groups	23.1	2.84
	Within groups	8.0	
Benefits	Between groups	8.8	0.44
	Within groups	19.8	
Attitude Index	Between groups	2270.7	4.36*
	Within groups	52.0	
Literacy	Between groups	71.9	3.86*
	Within groups	18.6	

Note. * $p <0.05$, ** $p<0.01$

Discussion

Both previous programming experience, even to the limited degree permitted for course admission, and the entry level of computer literacy were found to be significantly correlated with the final standing in the course. These results were predicted on the basis of a presumed relationship between prior learning and achievement. However, prior programming experience only promoted a liking of computers. It did not promote broad-based positive attitudes toward computers. This result is somewhat puzzling given the main result of the study: that training in computer programming skills resulted in an improvement in attitudes toward computer utilization. However, this result does suggest that perhaps a certain level of programming skill must be attained before significant attitude gains are produced. Presumably, the skill of the novices entering the course was below this threshold value. The development of positive attitudes toward computers was much more influenced by prior word processing experience than it was by prior programming experience. Based upon this result, it is suggested that preservice teachers should be given training in word processing prior to the introduction of other types of computer training to encourage the development of positive attitudes toward computers.

The lack of any gender effects in the data does not support the result reported by Baylor (1985) who found that programming engenders more positive attitudes in males than in females. However, the lack of a gender effect lends support to Chen's (1986) claim that males and females respond similarly to increases in computer experience with more positive attitudes. Gender was also found to be unrelated to computer literacy. Entry-level computer literacy levels and gains in literacy of the male and female students were indistinguishable. This result is also contrary to results reported elsewhere (Kay, 1989).

The results of the study indicate that gains in *these* students' attitudes toward computers *and* their level of computer literacy were outcomes, at least in part, of this elective course. However, it must be emphasized that the results of the study are dependent upon the sensitivity of the instruments used to measure attitudes. By basing the division of attitude dimensions upon a factor analysis of a large bank of items it was hypothesized that the results would be inherently more valid than results based upon dimensions imposed by the construction of individual scales. To some extent, the results support this hypothesis. The attitude scales, as analyzed in this report, underline the usefulness of word processing experience in the promotion of positive attitudes toward computer utilization among computer novices. They also serve to better distinguish between the dimensions of Computer Anxiety and Computer Liking than do the scales of Gressard and Loyd (1986).

Conclusions

The purpose of this pretest/posttest investigation was to study the computer attitudes and literacy of a group of 36 preservice teachers enrolled in a programming oriented computer training course. The results of the study indicate that the course goal of providing the preservice teachers with basic programming skills as a means of promoting the utilization of the computer for educational purposes was achieved. Rather than diminishing the subjects' attitudes toward computer utilization, the emphasis on programming appeared to result in a general increase of positive attitudes — particularly that of Computer Liking.

This demonstration that programming training can enhance preservice teachers' attitudes toward computer utilization is important for curriculum designers since these attitudes play a crucial role in preservice teachers' commitment toward using computers in the classroom (Kay, 1990) and their implementation of any computer skills they acquire. (Randhawa & Hunt, 1984) Teachers will soon have little choice as to whether or not to use computers as instructional tools. For this reason, it is of critical social and educational importance to continue to research the circumstances under which teachers feel comfortable learning about and utilizing the computer as an essential tool for learning. Care must be taken to design introductory computer courses for preservice teachers that ensure the development of their computer literacy while enhancing their attitudes toward computer utilization. Both factors are fundamental to the expansion of the educational use of computers. The problem facing curriculum designers is how best to achieve these two goals. The results of this study do not address the fundamental question as to whether or not programming is really a necessary skill or is it just a hurdle to the acquisition of the skills that the preservice teachers really want and will actually use? If, as some suggest, that programming is an outdated skill, then perhaps computer training courses should avoid this topic altogether. This question merits further consideration and investigation.

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Investigating Middle School Mathematics Teachers' Attitudes toward Calculator Use

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Abstract

This study examined middle-school mathematics teachers' attitudes toward calculators and investigated whether or not there were significant differences by grade-level taught, years of teaching experience, and teachers' educational degrees. The results revealed that nearly all of the teachers enjoyed working with calculators; however, one-fifth of them expressed some concern about students use of them. Analyses of variance results indicated that eighth grade teachers had more favorable attitudes than sixth grade teachers. Teachers with master's or higher degrees had more positive attitudes toward calculator use than teachers with bachelor degrees. The implications of these results for teacher education are discussed in the paper.

Introduction

Although the use of calculators in mathematics classrooms is being widely advocated by educators and professional organizations (Ayers,1991; Hembree & Dessart, 1986; Mathematics Sciences Education Board, 1990, National Council of Teachers of Mathematics, 1989, National Research Council, 1989; Szetela & Super, 1987; Willoughby, 1990), there have been relatively few research studies that have specifically examined teachers' attitudes toward calculator use. In a study that assessed school-wide impact of calculator integration on mathematics achievement and attitudes, Bitter and Hatfield (1991) found that using calculators significantly improved student mathematics achievement and that a majority of teachers supported the idea that calculators should be a regular part of the school curriculum. Terranova (1990) investigated elementary teachers' and principals' feelings and beliefs about calculators. He found that both teachers and principals believed that calculators should be used in elementary classrooms; however, teachers appeared to harbor fears about the effect of the use of calculators on students' learning.

Teachers' attitudes toward specific technology are very important because they are significantly related to the implementation of technology (Office of Technology Assessment, 1988). Teachers' commitment to implementing calculators in mathematics instruction affected students' performance on all ITBS mathematics subtests (Bitter & Hatfield, 1991). There have been a few recent national surveys examining middle school mathematics teachers' usage of calculators (see e.g., Pagni, 1991-92), but there have not been many studies that have specifically examined teachers' general attitudes toward calculators nor investigated whether characteristics such as grade-level taught, years of teaching experience and educational degree impact attitude.

The purpose of the present study is to investigate middle school mathematics teachers' attitudes toward calculators and examine whether teacher characteristics have different effects on their attitudes. More specifically, this study explores the following research questions:

(1) What are the general attitudes of middle school mathematics teachers towards the use of the hand-held calculator in the classroom?

(2) Are there significant differences by (a) grade level taught, (b) teaching experiences, and (c) teachers' education on their attitudes toward calculator use?

Method

Subjects

The subjects in the present study were 57 middle school (i.e., grades 6, 7, & 8) mathematics teachers from a multi-ethnic, metropolitan school district located near a large, urban city in the South Central Region of the United States. The teachers were about to receive specific training on how to appropriately implement the calculators in their classes. Also, after completing the training all of their students were going to receive Texas Instrument Calculators.

The subjects had taught for an average of 11.2 years, ranging from 0 (beginning teachers) to 26 years. Slightly over 80% (46) of the teachers were female and nearly 20% (11) of them were male. About 55% (31) of the teachers had completed a master's or higher degree, and 45% (25) of them had obtained a bachelor's degree. Nearly 40% (22) of the teachers were teaching 6th grade, 30% (17) were teaching 7th grade, and over 30% (18) 8th grade.

Instrument

The instrument used in the present study was a revised version of the Pocket Calculator Attitude Scale (Bitter, 1980) which has been previously found to be reliable (r=.95) and valid. This scale consisted of 20 statements assessing teachers' attitudes toward pocket calculators in general and toward students' calculator use for learning mathematics. Subjects responded on a five-point Likert type scale, where teachers indicated their level of agreement with each statement by responding either SD (Strongly Disagree), D (Disagree), NS (Not Sure), A (Agree), or SA (Strongly Agree). A score of 5 indicates that the teacher strongly agreed with the item, while a score of 1 indicates that the teacher strongly disagreed with this item.

Procedures

The calculator attitude scale was administered to all the subjects at the beginning of the Fall semester. The teachers who had taught 5 years or less were grouped together as the low teaching experience group, teachers who had taught 5 to 15 years as the median teaching experience group and teachers who had taught more than 15 years as the high teaching experience group. A three-way multivariate analysis of variance was used to determine if there were any statistically significant differences ($p < .05$): (a) among teachers of the three grade levels, (b) among the three teaching experience groups, and (c) between two educational levels of teachers on their attitudes toward calculator use.

Results

Table 1 reports the percentage of these middle school mathematics teachers' responses on the 20-item survey. For the purpose of discussion, responses of "Strongly Agree" and "Agree" were grouped together as well as "Strongly Disagree" and "Disagree".

Overall, the findings revealed that these teachers held positive attitudes towards calculator use. Over 90% of the teachers responded that: (a) calculators were neat, (b) working with calculators was fun, (c) they liked calculators and enjoyed using calculators, (d) calculators should be allowed in the school, and (e) the use of calculators for game and fun should be encouraged. About 85% of the teachers responded that (a) calculators make mathematics fun, (b) calculators should be an integral part of the curriculum, (c) I want calculators for all students, and (d) I have a growing appreciation of calculators through understanding their applications to the school curriculum. More than 75% of the teachers responded that calculators can stimulate a child to study mathematics and should be available for students in all grades.

Nonetheless, only 50% of the teachers responded that students should be allowed to use calculators while taking mathematics tests. Over 25% of the teachers expressed concerns about students' use of calculators, indicating that calculators do not allow students to do simple mathematics. Furthermore, about 20% of the teachers responded that calculators will cause students to not understand the basic computation skills or to lose the chance to do mental computations.

The MANOVA results indicated that there was no overall significant difference by grade level taught, teaching experience, nor educational levels of teachers. However, further investigation indicated that there were significant differences ($p < .05$) on some individual attitude items by grade level taught and level of teacher degree held.

Analysis of variance results by grade level taught indicated that teachers of different grades held significantly different attitudes toward whether (a) calculators can stimulate a child to study mathematics, ($F = 3.27$, $p < .05$); and (b) calculators should be an integral part of the curriculum ($F = 4.25$, $p < .05$) . The Duncan multiple range comparison further revealed that the mean of the 8th grade teachers was significantly higher than those of the 6th and 7th grade teachers on the item that calculators

Table 1 - The percentage of Teachers' Responses on the Calculator Attitude Scale

Item		Strongly Disagree or Disagree	Not Sure	Strongly Agree or Agree
1.	Calculators should be an integral part of the curriculum.	0	14	86
2.	I get no satisfaction from using calculators.	91	7	2
3.	I want calculators for all students.	0	11	89
4.	Calculators are too expensive for classroom use.	82	11	7
5.	Calculators are neat.	2	7	91
6.	The use of calculators for games and fun should be encouraged.	5	2	93
7.	Students should be allowed to use calculators while taking math tests.	57	20	23
8.	I have a growing appreciation of calculators through understanding their application to the school curriculum.	5	11	84
9.	I have never liked calculators.	96	2	2
10.	Working with calculators is fun.	0	9	91
11.	I am afraid to work with calculators and use them in the class with students.	82	11	7
12.	Calculators will cause students to not understand the basic computation skills.	58	23	19
13.	Calculators should be available for students in all grades.	12	12	76
14.	I don't feel calculators should be allowed in schools.	96	2	2
15.	Most schools will have calculators available for students in 1990.	42	40	18
16.	Working with calculators is boring.	93	7	0
17.	The use of calculators is causing students to lose the chance to do mental computations in school.	58	21	21
18.	Calculators can stimulate a childto study mathematics.	5	16	79
19.	Calculators do not allow studentsto do simple mathematics on paper.	62	12	26
20.	Calculators make mathematics fun.	5	7	88

can stimulate a child to study mathematics. In addition, the mean of the 8th grade teachers was significantly higher than that of the 6th grade teachers on the item that calculators should be an integral part of the curriculum.

Analysis of variance results by teachers' educational level revealed that mathematics teachers with a master's or higher degree held significantly different attitudes from teachers with a a bachelor degree on three items: (a) they get no satisfaction from using calculators ($F = 4.23$, $p < .05$) (b) I' m afraid to work with calculators and use them in the class with students ($F=5.96$, $p < .05$) and (c) calculators do not allow students to do simple mathematics on paper.

In general, the means of mathematics teachers with a bachelor-degree were higher than the means of master-degree teachers on the three negative items. In other words, master-degree teachers' attitudes were significantly more positive than bachelor-degree teachers toward using calculators by themselves and by their students.

Discussion

The results of the present study confirm various previous research findings. Middle school mathematics teachers generally favor using calculators (Bitter & Hatfield, 1991; Cohen & Fliess, 1979; Terranova, 1990). Teachers supported the use of the calculator, thought of it as an effective motivator, as an aid in computations, and as useful for mathematics enrichment. With a calculator in hand, both the teachers and students can concentrate on higher levels of cognitive learning rather than tedious computations.

Although some teachers expressed concern about possible negative effects of calculator use on students' learning, the percentage of teachers concerned before calculator training was relatively small in comparison with findings of previous studies. It is encouraging that 84% of the teachers felt a growing appreciation of calculators through understanding their applications to the school program. Due to the efforts of a handful of educational researchers and organizations over the past decade, teachers have gradually become aware of the many uses of calculators and the conditions under which calculators can be used.

The results of the study further provide insights into various characteristics that may impact teachers' attitudes. Contrary to what one would quickly assume, years of teaching experience made no significant difference on teachers' attitudes toward calculators. Grade level taught showed significant effects on two attitude items. More eighth grade teachers than sixth grade teachers accepted calculators as an integral part of the curriculum and as a stimulator to students' learning mathematics. The difference may be attributed to the nature of the mathematics content covered at different grade levels. In middle schools, mathematics instruction proceeds from computation-oriented decimals, integers, and fractions to more advanced statistics and algebra. Teachers are more likely to allow and to encourage the use of calculators in higher level mathematics courses (Cohen & Fliess, 1979).

Perhaps the most noteworthy characteristics revealed in this study is the teacher's highest educational degree. In general, teachers with master's degrees demonstrated a more positive attitude toward calculator use than teachers with bachelor degrees. Master-degree teachers showed significantly greater satisfaction and confidence in using calculators and less concern about the notion that calculators do not allow students to do simple mathematics on paper. Examination of the data indicates that these degrees held by teachers were mainly education-related, i.e., mathematics education, special education, and so forth. This implies that graduate level teacher education enhances teachers' attitudes toward calculator use. Because teachers' attitudes have been found to be directly related to their implementation of the use of calculators in mathematics classes and to the improvement of students' mathematics achievement (Bitter & Hatfield, 1991; NRC, 1989), it is important that all education decision-makers cultivate an environment which encourages mathematics teachers to pursue higher degrees. Graduate studies provide a greater opportunity for both pre-service and in-service teachers to be exposed to innovative educational technology. It is also critical that teacher education institutions incorporate calculators as well as other technology in their teacher preparation programs. "The quality of teachers and teaching is essential to meeting our goals" (Bush, 1991). In order to strengthen mathematics education, mathematics teachers need instruction on how to integrate calculators into their mathematics curricula. Further research is needed to determine other significant characteristics as well as to design the most effective undergraduate and graduate courses that can help mathematics teachers integrate calculators into their curriculum.

Acknowledgement

This research is supported in part by the Department of Education R168D00311 Eisenhower Grant. The opinions and views presented in this paper do not necessary reflect those of the granting agency.

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A Look at the Attitude of Elementary Teacher Preparation Students Toward Microcomputers: A Progress Report

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Abstract

Elementary Mathematics Methods students were given a microcomputer attitude scale before using the education computing classroom as an integral part of their instruction. Maintaining initial positive attitudes toward the use of technology appears critical to its successful use in daily teaching. Several interesting attitude patterns were identified which will assist in planning future courses.

Introduction and Overview

In order for computer-based technology to be effectively integrated into the elementary classroom, it appears that teachers must be comfortable with and able to use the technology before they begin daily teaching. One of the important considerations is that future elementary teachers see the technology in the classrooms in which they are trained so that they have an effective model upon which to call when teaching their own classes. Teachers also need to understand how to integrate computers into existing curriculum and not just use it as a reward or additional topic.

Microcomputer Attitude Scale

During the Fall semester of 1991 the *Microcomputer Attitude Scale* developed by Abdel-Gaid, Trueblood, and Shrigley (1986) was given to 58 students as an indicator of students attitudes at the beginning of a semester. The This instrument is composed of twenty-three questions which focus on attitudes in five general areas:

1. The importance of microcomputers in the schools (10 items)
2. Student and teacher attitudes and anxieties toward microcomputers (4 items)
3. The effect of computers on student achievement and thinking skills (4 items)
4. Teacher/student involvement (extra workload, student contact, etc.) (3 items)
5. The importance of programming skills (2 items)

This sample group of methods students (n=58) appeared to be quite sophisticated in their views and attitudes toward computers in the public school curriculum. The overall mean pretest item response was 3.03 on a 4 point scale with 4 being the most positive attitude. The standard deviation of these individual item responses was 0.80. Considering all the items together, the mean score on the instrument was 69.76 where the highest possible score is 92 and the lowest is 23. The standard deviation for the total score is .80 indicating a tight grouping of scores. The results of this analysis are shown in Table 1.

TABLE 1
Microcomputer Attitude Scale summary

Item Category	Mean Total	Mean per item	SD per item
1. Importance of microcomputers (10 items)	29.44	2.94	0.70
2. Attitudes & anxieties (4 items)	12.13	3.03	0.60
3. Achievement & thinking skills (3 Items)	12.16	3.04	0.65
4. Involvement (2 items)	9.59	3.20	0.75
5. Programming skills (2 items)	6.48	3.22	0.24
ALL ITEMS	69.76	3.03	0.80

The items in Item Category 1, the importance of microcomputers in the schools, had a mean response of 29.44 which is quite high since the maximum possible for these ten items is 40. The implication is that this group of students believes that microcomputers are very important in the classroom.

The items asking about the role or importance of programming to both students and teachers has a similar response pattern. In the pretest students had a very strong attitude that students and teachers should both be taught to program computers.

The items related to teacher/student involvement indicated a very high positive attitude on the part of the students. The methods students in this sample came into the semester feeling that all teachers should be taught how to use microcomputers. These methods students also felt that too much attention and emphasis was being given to computer technology and that this detracted from the real problems in the schools. By the end of the semester perhaps that position will change and students will feel that the emphasis on technology is warranted.

Items dealing with student and teacher attitudes and anxiety showed a remarkably high positive attitude among this sample of students. The methods students seemed to hold the belief from the beginning that both teachers and students would not have increased anxiety with the increased use of microcomputers. There was also a high positive attitude on the pretest indicating a strong belief that microcomputers would improve student attitudes toward school subjects.

Summary

The attitudes held by students in any computer education course are important to the outcomes in that course. As reported here, instructors can gather a great deal of information by using simple surveys at the beginning of their courses. This is a practice that should be common place in all computer education classes.

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Collaborative Writing and Electronic Feedback: An Evaluation of *For Comment*

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Abstract

For Comment, document review software for the IBM PC and compatibles, was used in an advanced research design course with doctoral students in Education. Electronic feedback, in the form of comments and suggested revisions, was provided for student papers by the instructor and students in the course. Generally, students preferred the use of electronic feedback to feedback provided on paper documents. They also tended to prefer both peer and instructor feedback to instructor-only feedback. The public nature of the feedback was viewed both positively and negatively. The major difficulty identified was learning new technology at the same time as learning new content. Flexibility in the manner is which the program is used is advocated, along with use of the program for both feedback and instructional purposes. It is further suggested that this technique be applied to, and evaluated in, other components of teacher education such as the preparation of instructional materials.

Introduction

There has been a great deal of research on the role of computers and word processing in classrooms (Cochan-Smith, 1991). Much of this research, however, has focused on pre-college programs or courses specifically focusing on writing at the college level (Anderson-Inman, 1991; Wedell & Allerheiligen, 1991). There also has been a great deal of research on the use of collaborative writing (Herrmann, 1989; Spaulding & Lake, 1991). Most of these studies used computer-based writing, but feedback was often given on printed copies of the documents. A major exception to this general trend is the work of Batson (1989) and others who have developed tools for collaborative writing and conferencing such as *Deadalus* and *Real Time Writer*. In addition, Lunde (1991) examined the use of electronic mail as a method for writing and language instruction. In teacher education, much of the research and literature on computer-based writing has focused on teaching future teachers how to use computers in precollege classrooms (Roos, 1991). However, little attention has been directed to the effects of computer-based writing within the teacher education program itself.

This report summarizes an evaluation study of a computer-based collaborative writing project within a doctoral education course designed to teach students how to evaluate research critically and to synthesize a specific body of literature. The software program used in this course is *For Comment* (Access Technology, 1991). This application allows a group of individuals to review each other's writing and to make comments and suggestions for revision using the computer. In using this software, the original paper is not modified during the review process, although the author does have the option of accepting suggested revisions without having to retype them.

The primary purpose of the study was to determine the effects of three components of collaborative writing exercises on the development of scholarly writing skills. The components of collaborative writing which were addressed were (a) computer-based versus paper-based feedback, (b) instructor-only feedback versus instructor and peer feedback, and (c) public versus private feedback.

Method

Subjects

The subjects in this study were nine doctoral students enrolled in an advanced research design class at Gallaudet University, the world's only liberal arts college specifically for deaf students. One of the assignments in this class was to prepare a critical evaluation of a selected body of research literature. This writing assignment was used as the basis for the computer-based collaborative writing project. Although each student wrote a separate paper, the term collaborative is used here in terms of collaboration and review during the writing process itself.

Five students were enrolled in a doctoral program in Education: Deafness, three students were enrolled in a doctoral program in Special Education Administration, and one student had not yet enrolled in a formal doctoral program. Four of the students were deaf, and five were hearing. All communication in the classroom involved the use of sign language. Previous computer experience of the students varied dramatically (some students had no experience, others had used the Apple Macintosh but had no IBM-based experience, and others had extensive experience).

Measures

Primary sources of data for this study included: (a) an analysis of the numbers and types of comments made on papers by peers and the instructor during the course, (b) a survey of students concerning their perceptions about the project and the sense of community within the class, (c) student comments (collected via electronic mail) on problems associated with computer integration and implementation, and (d) an examination of the instructor's notes and thoughts concerning the integration of the computer and the needs of deaf students.

Procedures

The computer-based collaborative writing project involved production of critical reviews of research. During the semester, students provided three sections of their papers for peer review (using the *For Comment* program on a PC-based Novell network). All students were asked to review the sections and provide feedback. A draft of each complete paper was also reviewed by a single student. The instructor participated as a peer in the review process, but instructor comments were not added until after students had had a week in which to add their own comments. Following each round of reviews, the student authors exported their papers back to the word processor in which the original drafts had been prepared. They also had the opportunity to export copies of other students' paper and/or to print out copies of all papers with comments attached. Other assignments during this time used a standard paper-based, instructor-only review process. These assignments (reviews of single articles) provided the basis upon which students compared the two approaches used to review student writing. Questionnaires distributed at the end of the class were used to examine student perceptions about the project, the influence of the peer review process, and the effects on the sense of community within the class.

Results

The results of the study will be presented according to the research questions that formed the basis of the study.

How do students rate the use of a computer-based, peer and instructor review process as opposed to a paper-based, instructor-only review process?

Students were asked to rank order six different types of feedback that could be provided for papers, using a scale from 1 (worst approach) to 6 (best approach). The

Table 1.
Mean Rank and Standard Deviation for Six Types of Feedback
(N=9)

Type of Feedback	Mean Rank	(Standard Deviation)
Paper, instructor-only	2.67	(1.80)
Paper, instructor and peer.	2.67	(1.00)
For Comment, instructor-only (public)	3.00	(1.00)
For Comment, instructor-only (private)	4.22	(1.79)
For Comment, instructor and peer (instructor comments private)	4.11	(1.27)
For Comment, instructor and peer (instructor comments public)	4.33	(2.18)

means and standard deviations for the types of feedback are presented in Table 1. A Friedman test indicated that there were no significant differences in the rank scores $[c^2(5, N=9) = 8.30, p = .1404]$. This may be due to the small sample size. There appears to be a preference for computer-based *(For Comment)* feedback, except when the instructor is the only reviewer providing public feedback. In this study, public means that papers and feedback are accessible by all students in the class.

In terms of students doing peer review, two students would have preferred to do paper-based reviews, three students did not have a preference, and four students preferred to do computer-based reviews.

As identified by the students and instructor, some of the benefits of using the computer-based review process included: (a) more emphasis on cooperation than on competition, (b) more extensive feedback provided via the computer, (c) access to others' papers, (d) ability to print document with feedback, (e) ability to access all papers electronically (for future revision), (f) ability to link comments directly to lines in the document, and (g) ability to compare one's own progress to that of peers. Several students also reported that the instructor responded more quickly using the *For Comment* system than when providing feedback on paper. (No systematic data were collected on this, so it is impossible to know whether this perception was accurate or not).

How do students respond to their work and feedback on their work being made public?

Student indicated whether they preferred private access to their papers and the feedback on those papers using a Likert scale (SA=Strongly Agree, A=Agree, N=Neutral, D=Disagree, SD=Strongly Disagree, NR=No Response). These data are shown in Table 2.

These data indicate that the majority of the students did not object to having their papers made public, although half of the students expressed concern about the feedback being made public. Seven of the students indicated that the process of reviewing others' papers gave them ideas for how to write their own papers. All students exported at least some of their peers' papers.

How does computer-based, peer review affect the development of an understanding of the process of scholarly review?

All, except one, of the students believed that experiences in the course the students believed that the use of *For Comment* contributed to their sense of being a member of a small scientific community within the course.

How can the use of a computer-based collaborative writing tool be integrated into a content-focused class (as opposed to a class focusing on the role of technology)?

During the initial session with *For Comment*, the instructor demonstrated the program using IBM's LANSchool (which allows students to see the instructor's display on their individual monitors). Students then began using the computer to review their peers' first papers. (Prior to class, the instructor had imported the papers into the program so that students could focus initially on the process of reviewing only).

After the initial session, the instructor and students engaged in a discussion (using e-mail) concerning the difficulties associated with (a) using LANSchool for which the deaf students had to constantly switch their attention from their personal monitor to the instructor, and (b) providing adequate help for students unfamiliar with computers while allowing more experienced students to go forward on their own. Various strategies for dealing with these problems were identified and implemented later in the course.

Later sessions were devoted to teaching students how to print the combined paper-feedback documents, import documents into *For Comment*, and export the documents back into the native word processing format. Each of these sessions took 30-45 minutes, with different approaches being used. For printing, students were given step-by-step written instructions and expected to proceed independently (or in small groups). For importing documents, a brief demonstration was shown (using LANSchool with more carefully orchestrated shifts from the computer screen to the discussion), followed by time for individual practice. For exporting documents, the instructors taught two students who arrived early for

Table 2
Responses to Statements Concerning Public Access to Papers and Comments
(N=9)

Statement	SA	A	N	D	SD	NR
prefer no public access to paper	2	0	2	3	2	-
prefer no public access to comments (feedback)	2	2	0	2	2	1

class, and then the instructors and these students taught the others in small groups. Individual practice time was also provided.

During the first half of the semester, many of the students expressed concern about the difficulties of having to learn the technical aspects of using the computer at the same time as trying to improve their skills in scholarly writing and critical evaluation. However, at the end of the course, only one student raised this issue on the questionnaire (when prompted to list negative aspects of using *For Comment*). When asked to respond to a statement concerning the difficulty of learning to use *For Comment* (at the end of the course), two students agreed that it was difficult, two students were neutral, two students disagreed, and three students strongly disagreed. Two of the students also expressed a different type of difficulty. These students used Macintosh -based word processors. A faculty member (with a Macintosh computer in his office) converted the documents for these students. Because that faculty member was in a different building, however, the process took longer, and there were difficulties in preserving the formatting of Microsoft Word documents (from the Macintosh) when importing into *For Comment* . In addition to providing feedback on student work, *For Comment* was used for two other activities. First, during a class on data analysis techniques, the instructor provided students with samples of data, descriptions of data analysis techniques, and results from published research reports. These samples were then critically evaluated by the instructor and students. Because the purpose of the lesson was to develop the students' own critical skills, the instructor's comments and evaluation was not provided on the handout. After class, the instructor then put the handout into the *For Comment* system and provided the students with a detailed analysis of each of the studies, incorporating both her own and the students comments. This revised handout was then printed out and distributed to the students. Second, *For Comment* was used to achieve what is sometimes called "Every Student Response." In the standard lecture situation, an instructor asks a question and only one student can answer at a time. In a "Every Student Response" situation, all students respond to the question simultaneously; thus each student is actively engaged with each and every question. During a class on experimental research, descriptions of experimental studies were provided in a *For Comment* document, and students were required to identify the specific experimental (research) design being used; to categorize the studies into true experimental, quasi-experimental, or pre-experimental studies; and to identify the threats to internal and external validity associated with those research designs. Students worked in small groups on this exercise for approximately an hour and a half. (The small group format, in some ways, contradicts the goal of "Every Student Response," but it encourages collaboration, which was another goal of the project). Each group used an anonymous logon ID so that individual responses could not be identified. The instructor then used an LCD projection panel to display the responses and to discuss the exercise. [It should be noted that this part of the exercise was not completely successful due to the inability to find a palette on the projection panel that could display the document and the comments simultaneously.]

How might the process of computer-based collaborative writing be revised in future implementations of this approach?

Discussion of ways to modify the process occurred throughout the course: in class, outside of class, and via e-mail. In addition, students were asked to suggest ways to modify the use of *For Comment* on the questionnaire distributed at the end of the course. One suggestion made was that the initial training include discussion of the process of providing constructive criticism Initially, there was some concern that peers were too critical or that they focused too much on mechanical aspects of the papers. Another group of suggestions related to access. Students believed that it was inconvenient to have to come to the computer lab to provide feedback to peers. They desired more time during class for commenting, access via modems, and/or access to the program in other locations on campus or at home. The instructor would also emphasize the revision component of the program more extensively. Students tended to use comments, even when they were suggesting revisions in the text. The instructor would continue varying the use of *For Comment* as an instructional aid and as a feedback mechanism. She would also incorporate both identified and anonymous comments, as well as both public and private feedback.

One limitation of *For Comment*, the inability to display *WordPerfect* tables or information in columns, will continue to be a problem. Although the instructor converted simple tables to TAB-separated fields, the review of complex tables was handled off-line. One possible work-around would be to use the comment function within *WordPerfect* to provide feedback on tables, but *WordPerfect* does not display comments if they are attached within tables.

Finally, the use of a projection panel or large-screen monitor appears to have greater promise for meeting the needs of deaf students than the LANSchool solution. When the computer screen is projected and the instructor (or speaker) is standing near that projection, students can more easily switch attention between the display and the speaker. The school has recently acquired a color projection panel, and this may solve the problems of palette choices. Alternatively, the color combinations can be adjusted within the *For Comment* program. Due to limited time during class and the inability to obtain the projection panel before class for testing, such a solution was not explored during the current study.

Discussion

The major finding of this study is that the use of *For Comment* appeared to be well-received by students. There were difficulties associated with trying to learn how to use new technology at the same time as learning new content, along with other implementation problems, but the overall evaluation was generally positive. The public nature of the feedback was viewed both positively and negatively. Peer and instructor feedback was perceived somewhat more positively than instructor-only feedback, although this finding must be qualified in that some students (a) believed there was insufficient time for peer feedback, (b) felt that some peer feedback was not constructive, and (c) were opposed to having peers review their work.

The existence of student resistance to peer review, however, should not be taken as evidence that such review is undesirable. As noted above, there were both positive and negative responses to peer feedback. Inclusion of a training session to direct peer feedback might reduce the resistance. The instructor should also determine carefully whether the feedback for a particular document should be made public or private. Inclusion of this option in the *For Comment* program would allow this decision to be made at the level of the individual comment.

This study is limited by the fact that the researcher was also the instructor for the course. Students were aware of the instructor's enthusiasm for providing feedback electronically and may not have expressed dissatisfaction as strongly as they might have to a researcher who was not involved in the process. Also, a direct comparison of the amount and/or type of comments provided on paper and by computer was not possible because the instructor was aware of the purpose of the study and thus an unbiased comparison was not possible.

Future research should examine the effects of electronic feedback with instructors who are not enthusiastic users of technology and with purposes other than those used in this study. For example, it might be interesting to see what effects use of an electronic feedback process would have on the development and sharing of lesson plans prepared by pre-service teachers. Perhaps two goals could be furthered in this way: (a) teaching future teachers to use computers as tools, by integrating such tool use into the pre-service preparation program, and (b) increasing the sense of professionalism and community among pre-service teachers by making them more active in and responsible for critically evaluating their own and others' work. Longitudinal studies would be necessary to determine whether these goals were actually realized.

Rigorous experimental designs should also be used to identify the relationships among the variables addressed in this study. One of the benefits of conducting the current study as a formative evaluation, rather than a rigorous experimental study, was that the methods of using *For Comment* could be modified dynamically as needed. Such a study, however, does not allow conclusions concerning the relative effectiveness of variables such as public versus private feedback, paper-based versus computer-based feedback, or peer and instructor versus instructor-only feedback.

Further studies will be needed to examine these relationships under more controlled conditions. Based on this instructor's experiences and those of her students, flexibility and variety in how *For Comment* is used appears to important. Thus, the program can be used both for feedback and for instruction. Students can be identified or anonymous in the review process, and comments can be public or private. In addition, flexibility in the manner in which the technical aspects of using the program are taught is important, in order to meet the varying levels of computer sophistication among the student population.

Acknowledgements

The authors wishes to thank the students in her class for their cooperation in this project. Appreciation is also extended to IBM for provision of the networked laboratory in which the study took place. Gallaudet University was the recipient of an IBM Teacher Education Grant in 1990.

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Collaborative Research: Using New Technologies in a Middle School Setting

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Abstract

This paper presents an overview of computer related action research conducted as part of a collaborative relationship among a university, a middle school and a government sponsored technology center. Five teachers conducted classroom research on the following topics: social interaction and computer use; using *HyperCard* as a research tool in social studies; computers as an aid to learning French grammar in an immersion setting; cooperative learning strategies using computers in science classes, and using multimedia (interactive laser disc) to teach science. The findings of each of the action research projects are discussed along with the teachers' suggestions for further enhancement of their practice.

Introduction

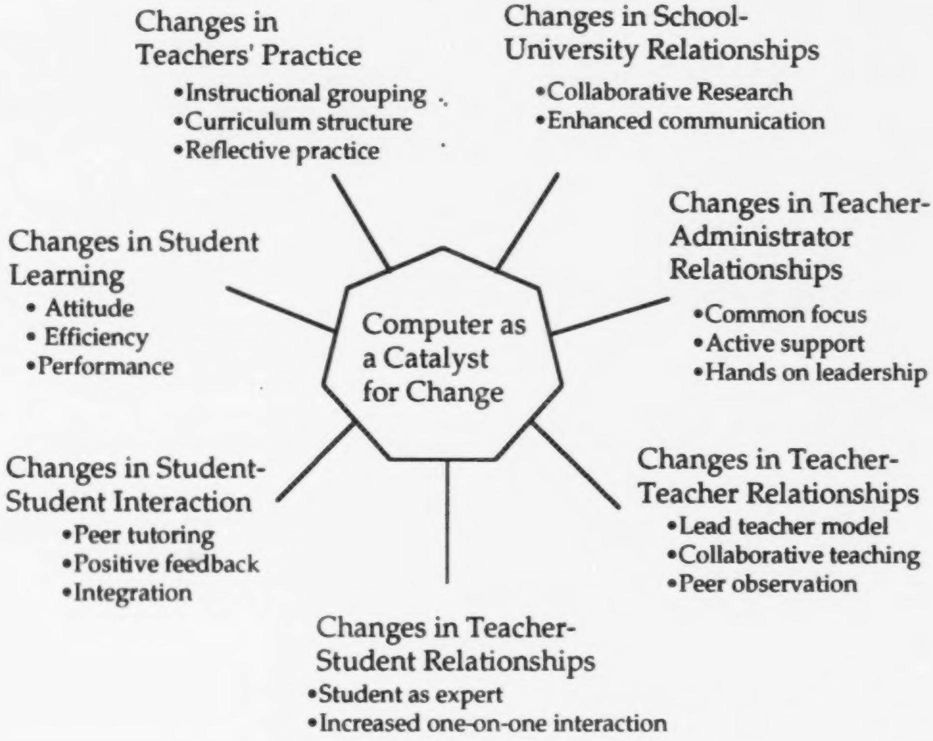
This paper describes a collaborative project linking players from a number of different educational arenas. During the past two years, teachers from Mount Newton Middle School in the Saanich School District of British Columbia, Canada, personnel from the Educational Technology Centre of British Columbia, Saanich School Board Office, and researchers from the Faculty of Education, University of Victoria have been exploring the potential uses of new technologies in education. Within the setting of Mount Newton Middle School, six teachers each undertook an action research project designed to explore some aspect of using new technologies in education. The Educational Technology Centre of British Columbia (ETC) with the generous support of Apple Canada, provided conceptual, financial and hardware support for the various projects, while personnel from the school board office provided organizational and administrative assistance. The University of Victoria research team liased with the teachers and ETC staff, offering suggestions and guidance regarding conceptual issues and the research process.

The action research described in this paper grew out of a collaborative partnership that was established in 1989 between Mount Newton Middle School, the University of Victoria, and the Educational Technology Centre. The partnership was originally designed to examine the inservice model that the school was using to develop a school staff that was technologically literate. Initially, the project examined staff perceptions of computer technologies, degree of satisfaction with existing inservice strategies and inservice needs for the future. The findings of that research are contained in a report entitled *Mount Newton Middle School Project: Final Report* which is available from the authors.

During the second year, the partnership shifted its focus to those aspects of technology use which had a direct bearing on the teachers' classroom practice. Because the focus was actual classroom practice, action research, which puts the teacher in the role of researcher, was chosen as the vehicle for investigation. In this way, the concerns and interests of the teachers were foremost in the research process. The topics that were investigated include the following: social interaction and the use of the computer in educational settings; using *HyperCard* as a vehicle for student research in social studies; cooperative learning in science using computers, using interactive videodisc to teach science; and using computers to help immersion students learn French grammar.

These projects each reflect some facet of educational change. Displayed graphically, the changes can be seen as occuring in seven main areas. (See Figure 1)

Figure 1


Changes in Teachers' Practice
•Instructional grouping
•Curriculum structure
•Reflective practice
Changes in School-University Relationships
•Collaborative Research
•Enhanced communication
Changes in Student Learning
• Attitude
• Efficiency
•Performance
Computer as a Catalyst for Change
Changes in Teacher-Administrator Relationships
•Common focus
•Active support
•Hands on leadership
Changes in Student-Student Interaction
•Peer tutoring
•Positive feedback
•Integration
Changes in Teacher-Teacher Relationships
•Lead teacher model
•Collaborative teaching
•Peer observation
Changes in Teacher-Student Relationships
•Student as expert
•Increased one-on-one interaction

The following sections summarize the action research conducted by the teachers.

The Effects of Computer Use on Social Interaction

Balaam (1991) examined the impact of computer technologies on interactions between students and between student and teacher. Her concern grew from her experiences as a teacher of special needs students, and from concerns that some parents had about negative impacts of new technologies on social interaction among children.

To answer the question "How does using a computer affect social interactions between student and student and student and teacher?" (p. 5), Balaam gathered data in two science and one art classroom. Using data from written observations, a personal journal, unstructured interviews, and videotapes of two class sessions, Balaam painted an essentially positive picture of the impact of computer technologies on social interactions.

Although her overall assessment was positive, there were instances when the computer appeared to have little or no effect on interaction. Balaam noted that the type of interaction that occurred depended largely on the way the technology was applied Balaam also observed student interaction and enthusiasm for activities appeared minimal when computer use involved completing a "paper-and-pen" (p. 14) task in which students' involvement consisted of just data entry.

Positive interaction was associated with four different aspects of computer use: 1) an increase in positive feedback and dialogue, which Balaam attributed to the computer monitor allowing students and teacher increased visual access to each others' work;

2) an increase in one-to-one interaction between teacher and students;
3) the realignment of traditional roles as students assumed the role of expert and peer teacher, and
4) an increase in students' willingness to ask peers or teachers for help when using computers.

Balaam argued that when students are working with computers, not only does the act of helping a peer boost student self esteem, but that asking for help does not carry the threat to self esteem that it might in a regular classroom.

Using *HyperCard* as a Vehicle for Student Research in Social Studies

Evans (1991) explored potential uses of *HyperCard* for helping eighth grade students learn about the Renaissance. She provided students with extensive access to both the school library and computer lab so the class could construct a series of linked *HyperCard* stacks about the Renaissance. She monitored the project through observations recorded in a personal journal, and through student journals.

To complete their projects, students gathered material from the library, organized and summarized the material and then entered it into a *HyperCard* template designed for the project. To facilitate use of a variety of information sources, and to reduce copying notes by hand, students were allowed to photocopy materials and store their reference material in individual folders.

In her analysis of the project, Evans had mixed feelings. She wrote, "In that my original plan was to throw the whole process into operation and see what happened, I was successful and I learned a lot. If I hoped to make a revolutionary discovery about how to make students do better research, then I certainly did not succeed" (Evans, 1991, p.9).

A number of factors were responsible for the mixed results of Evan's project. One was the logistics and limitations of operating a networked computer lab. Lengthy loading times for the software and difficulties in saving student work frustrated teacher and students. Another factor was a teachers' strike which reduced the time available for the project. A third factor was the way students related to *HyperCard*. Evans wrote,

> *The attraction of the HyperCard program is that it allows one to move through a variety of paths to make connections within large amounts of information. For this reason, it has enormous appeal to adults who have made many of these connections in their own minds and can now see them in a computer program in such a way that they are readily available to students. I find myself wondering whether the program means as much to children. (p. 3)*

Upon reflection, Evans realized what she hoped would happen, (i.e. students making connections and using *HyperCard* as a tool to organize information) was not compatible with using a predesigned template in which every card in the stack was basically the same. On the basis of her study, Evans made the following recommendations: (p. 10)

- Define the task so that the computer is essential to the completion of the task.
- Structure the task to involve "webbing" between different parts of a larger whole.
- Ensure the final product will be of use to students.
- Have computers available in the regular classroom setting.
- View the computer as any other useful tool; available and useful, but not an end in itself.
- If working with *HyperCard*, ensure that students are familiar with *HyperCard* prior to starting the project.

Computers in a French Immersion Setting

The focus of Gallant's (1991) project was to examine the effect of two computers in the classroom on sixth grade students' learning grammar in a French immersion setting. Past experience convinced her that students at this level were reluctant to study grammar, had difficulty understanding grammar rules, and seldom made transfers from grammar activities to their personal writing. She hoped that the novelty of a different approach to learning and practicing grammar rules would increase students' understanding of the concepts and improve their attitudes towards learning French grammar.

Gallant was unable to locate appropriate commercial software for the age group, audience, and grammar needs of her students. This problem, coupled with lack of time and the need to meet other curricular demands forced her to constantly rethink and question the direction she was taking. Eventually, she started using a teacher designed set of *HyperCard* activities for grammar drills. Students also did more writing using the computer since the spell-check in French made it easier for them to edit their work.

Some of these activities occurred in the classroom while others were in the school's computer lab. In both cases she felt the computers were assimilated into the students' activities and did not profoundly change the nature of the activity.

Gallant's observations included many outcomes not originally anticipated while failing to find a definitive answer to her original question. Although she saw no direct evidence that computers assisted students' learning French grammar, she noted students enjoyed using the computers in the classroom. Social interaction occurred frequently around the machines, with students discussing their assignments, commenting on each others' work, telling how they were using the machine, or even discussing a game they were playing.

Student productivity increased in several cases, as some students who formerly produced little written work were "writing" more when using computers. Gallant concluded that the neater appearance of the typed assignment seemed to encourage some students to produce more work. She also noted that putting student work on computers changed the privacy of work. Whereas students might be hesitant to read another student's work on his or her desk, having it appear on a computer screen made the work "public".

Gallant also found that computers allowed more time for teacher-student interaction and even changed the nature of that interaction. Students who formerly seemed to discourage teacher coaching seemed more comfortable using computers, and were more amenable to teacher coaching.

Gallant's own words best summarize the nature of the many changes associated with computer use. She wrote, "I have frequently felt confused, frustrated, overburdened by, and ready to give up on this project. I have also felt surprised, proud, inspired, and several steps ahead in my own learning. The mere presence of computers in the classroom changed what we were able to do and gave us one more tool with which to do it" (p. 2)

Exploring the Potential of Using a Multimedia Approach in Teaching Intermediate Science.

Grewal (1991) investigated the potential of multimedia in improving the teaching and learning of intermediate science. Traditional teaching methods and materials were compared with a multimedia approach to instruction to determine differences in student achievement and attitudes toward science. Two aspects of multimedia were employed: a hypertext authoring system and an interactive computer-laserdisc.

The theoretical framework for this investigation was supported by cognitive learning theories that recommend the use of multimedia in teaching and learning. The work of Piaget, Bruner, and Montessori, was especially relevant.

Research conducted to date on interactive video indicated benefits were most prevalent on user attitudes and training time variables and less prevalent on the achievement variable. No pattern emerged on the performance variable. Bosco (1986) cited nineteen studies of which only three were negative toward using interactive video as an instructional tool.

A review of the literature indicated a lack of research on the effectiveness of the multimedia approach on student achievement and attitude in teaching intermediate science. This provided the impetus for Grewal's study which addressed the following key questions:

1. Will students who are exposed to a multimedia learning environment (i.e. interactive video) have significantly higher achievement scores in science than students exposed to traditional teaching methods?
2. Will students who are exposed to a multimedia learning environment (i.e. interactive video) develop significantly more positive attitudes toward science than students exposed to traditional teaching methods?

A pre-test was administered to both classes to determine students' background knowledge. A science attitude rating scale was used to measure general attitudes toward science.

The control group was taught using traditional methods and materials. Students completed written assignments and participated in lab activities on the human body. The experimental group was taught the same unit using a multimedia approach including an interactive video system, a computer, an overhead liquid crystal display (LCD), and *HyperCard*. The same teacher taught both the control and experimental groups.

The experimental group completed a *HyperCard* project on a system of the human body using a predesigned *HyperCard* template, graphics, and information from their texts. Students also kept a record of their thoughts and ideas in a daily learning log. At the end of the unit, a post-test and an attitude rating scale were administered to measure achievement and student attitudes toward science. The teacher was also interviewed to obtain his thoughts and opinions about the potential of this technology.

Preliminary results indicate that no significant differences in achievement scores in science were observed between students exposed to the multimedia learning environment and those exposed to traditional teaching methods. However, results suggest that students exposed to a multimedia learning environment developed more positive attitudes toward science than students exposed to traditional teaching methods. The results support the findings of Bosco (1986) where benefits were most prevalent on user attitudes and less prevalent on the achievement variable.

There is enough research evidence at this time to justify the acceptance of interactive video technology as a viable educational tool. The applications of interactive video to science teaching are numerous. Further studies can help identify the full potential of this technology in science education.

Cooperative Learning Strategies Using Computers in Intermediate Science Classes

Demchuk (1991) investigated cooperative learning strategies using computers in seventh and eighth grade science classes. Each class was divided into six groups selected according to different learning styles. Tasks were set according to learning styles and each group was given a choice of four to six different ways to approach each assignment. Each group selected one approach, i.e. research project, skit, etc.

The seventh grade classes worked on a Water Unit using Microsoft Works and Superpaint. The eighth grade classes worked on an Environmental/Earth Science Unit combining classroom and outdoor activities. Data was collected from the school yard and students used Microsoft Works to store and graph information. Students used *HyperCard* to display their findings.

Each group maintained a journal. The role of journal-keeper was assigned to one student in each cooperative group who watched, listened, and made notes for the whole class period and also asked questions to find out what other group members were thinking. Many positive thoughts and feelings were expressed as well as frustrations and difficulties. Teachers and students maintained an ongoing dialogue using anecdotal reports and comments. This helped the teacher understand the metacognition occurring with each group member. The anecdotal reports and comments formed part of the evaluation process as did tests and exams similar to those used in previous years. The overall results indicated that students did significantly better on final exams using this cooperative approach than in previous years.

Demchuk observed that the groups worked well despite the fact that many groups had students who would not normally work together. Students frequently had to make choices and decisions for their groups but the decision making process seemed to work quickly with very few problems.

In planning her research for the coming year, Demchuk suggested the following changes: 1) work with two classes instead of five; 2) maintain a more detailed portfolio of student work samples on disk; 3) use photos and tape recordings to monitor student progress; 4) clearly identify the focus of the project. Demchuk emphasizes the importance of ongoing reflection and revision in action research.

Conclusion

Proposed curriculum reform in British Columbia advocates learner-focussed programs and a fundamental redefinition of the teacher's role (Hoebel & Mussio, 1990). Rather than acting as an intermediary between information and students, the teacher is now seen as facilitating the direct interaction of students with information. The teacher's unique expertise exists in applying professional knowledge about how learning takes place, in creating meaningful learning environments, and in modeling how to be a life long learner.

The student's role is also changing according to Hoebel and Mussio. The student is now seen as a learner who constructs personal knowledge and creates meaning within a personal and social context. Each learner is fundamentally responsible for his or her own learning. The teaching/learning environment should reflect this principle, in ways that are appropriate for each learner. Computer mediated technologies can play a key role in assisting teachers to meet the needs of individual students . The action research studies conducted in this project support these changing roles.

Acknowledgements

In addition to the teachers whose research is reported herein, the authors appreciate the assistance of the following in the realization of this project:

- *Keven Elder, Director of Instruction (Technology), Saanich School District;*
- *Betty Clazie, Principal, Mount Newton Middle School;*
- *Colin Collister, Science teacher, Mount Newton Middle School;*
- *Jerry Mussio, Executive Director, Education Technology Centre of B.C.;*
- *Mike Hoebel, Manager, Research and Development, Education Technology Centre of B.C.;*
- *Elizabeth Wellburn, Researcher, Research and Development, Education Technology Centre of B.C.;*
- *Larry Yore, Department of Social and Natural Sciences, University of Victoria;*
- *Apple Canada.*

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Effect of an Integrated Microcomputer Project on Science and Mathematics Achievement

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Abstract

This research will provide educators with information on the effectiveness of various methods and programs of employment of microcomputers in the science and mathematics curriculum and its effect on student achievement. A survey was used to to provide data on computer use within their schools. Analysis of the data indicates that teachers see positive changes at all cognitive levels from using computers for educational purposes. These changes are in part due to the students choosing to use computers for homework and other tasks in addition to use of computers at the school. Students and teachers have recognized the benefits to be gained from using computers in class and at home. The conclusions of the study are that integrated computer learning systems have the potential for positive changes in the cognitive levels of learning science and mathematics, when properly implemented.

Introduction

In the United States, students need improvement in cognitive skill levels in science and mathematics (The National Commission on Excellence in Education 1983).

The American Association for the Advancement of Science, Science for all Americans Project 2061 (1989), states that:

> *The terms and circumstances of human existence can be expected to change radically during the next human life span. Science, mathematics and technology will be at the center of that change-causing it and shaping it, responding to it. Therefore, they will be essential to the education of today's children for tomorrow's world.*

The state of Arkansas is aware of these realities and has taken action to improve the educational opportunities through the implementation of a project aimed at improving the state's educational system using microcomputers as an aid to learning. (Arkansas Commission on Microcomputer Instruction, 1987) The effort, Project IMPAC (Instructional Microcomputer Project For Arkansas Classrooms), has been in operation for seven years. (McDermott, 1987)

The purpose of this study is to provide educators with information and data on the educational effectiveness of computer aided instructionin its various forms. The study provides querried: (1) the effectiveness of an integrated computer program (Project IMPAC) used for educational purposes in the elementary grades (K-6), (2) the effect of this program on the educational achievement of students in the secondary grades (7-12), (3) the educational effectiveness of schools using computers that are not in Project IMPAC and (4) the attidude and use of computers in the classroom and at home by science and mathematics teachers and students.

When asked "In your opinion, do microcomputers have potential in science education?" 86 teachers (87%) indicated positively while eleven (11%) indicated that they see no use for computers in education. Two respondents (2%) had no opinion. Another question asked was "Do you utilize microcomputers for instruction in any way in your classroom or lab?" this resulted in 99 responses of which, 36 (36%) use computers in their classrooms and 53 (54%) do not. However, when asked, "Do you use your computers to monitor real time experiments in labs?" of 80 responses, five teachers answered positively (6%) and 75 (94%) teachers answered negatively. An data related to the use of microcomputers in various science courses are presented in Table 1.

Table 1
Use of computers in secondary science courses

Course	Response	%
Jr. High Earth Science	13	23
Jr. High Life Science	10	18
Sr. High Earth Science	5	9
Sr. High Biology	7	12
Sr. High Biology II	3	5
Sr. High Chemistry	5	9
Sr. High Physical Sci	4	7
Sr. High Physics	10	18
Sr. High General Sci	0	0

Teachers further provided information on the implementation and utilization of computers in education when asked "What problems have you had in implementing or utilizing microcomputers?" by ranking the following problems with one being the biggest problem and five being the least: (1) lack of in-service training, (2) lack of software, (3) lack of funds, (4) lack of hardware, (5) lack of school interest. Results are tabulated in table 2. Responses indicate that the biggest problem schools have in implementing a system of computer instruction in science and mathematics is funding, followed, not unexpectedly, by lack of hardware and lack of training. These three problems are all capital intensive, and teachers mentioned that their school districts simply did not have the funds to support a computer learning program on their own. Teachers interviewed informally and those that wrote comments submitted with the survey document felt that software is not now a problem, but that the cost of the new computers that can run the new software is. The data related to this question are presented in Table 2:

Table 2
Problems in Implementation and Utilization of Computers in Science and Math

	least 1	2	3	4	greatest 5
Problem	***Number of Respondents***				
Lack of training	12	12	8	3	5
Lack of software	2	8	19	7	3
Lack of funds	0	1	4	8	29
Lack of hardware	3	10	7	14	7
Lack of school interest	20	8	1	8	1

When asked to "Indicate your method of utilizing computers in your courses," from a list of seven different methods, teachers provided the following information as presented in Table 3:

Table 3
Teacher utilization of computer applications

Method	Respondents	%
Simulation	21	25
Word processing	15	18
Lab monitoring	4	5
Drill and practice	26	31
Data base	8	10
Interactive video	7	8
Other (grade book)	2	2

Interviews were held with teachers. The topic of these interviews was teacher training and in-service on using computers in education. Many teachers (53) responded that they had attended an in-service while 46 indicated that they had not. The teachers were then asked to provide information on the usefulness of the inservices. The results of this question are presented in table 4. The average rating for the 53 respondents to this question is 2.88 indicating that the participants found these in-services to be slightly less than useful.

Table 4
Teacher in-service rating

Rating		Respondent	Percent
1	Very useful	13	25%
2		4	8%
3	Useful	18	35%
4		8	16%
5	No use	8	16%

Teachers were asked to poll their students about computer use in the home. Out of a total of 3932 students responding to these questions, 949 (24%) of the students responded that they have and use microcomputers at home.

Teachers were then directed to ask students whether they used any of the following applications: (1) word processing, (2) data base, (3) arcade games, (4) adventure games, and (5) simulations. The results of this questions are presented in Table 5:

Table 5
Affirmative use of computer applications at home by students as reported by their teachers

Application	Number of teachers	Percent
Word processing	29	19
Data base	21	13
Arcade games	54	35
Adventure games	37	24
Simulations	14	9
Homework	27	15

Conclusions

The data provided by the survey instrument indicate that teachers do see positive changes in all of the cognitive levels through the use of computers for specific educational purposes. These positive changes are in part because of the students choice and have nothing to do with any integrated program at the school. The students and teachers have recognized the benefits to be gained from using computers for educational purpose both in class and at home.

The secondary schools may have a computer in a science or mathematics class, but it is not used as an integral part of the curriculum. These computers are used for enhancement activities and occasional laboratory exercises. In almost all secondary schools, computers are set up in the business classroom and cannot be used for science and mathematics activities on a regular basis.

The main use of software as reported by teachers is word processing and data base applications. There are some teachers that utilize simulation software, especially in biology and in physics. The mathematics and physics teachers utilize programs that enable students to make graphs and display geometric figures.

Recommendations For Improving Our Use of Computers For Education.

1) In-service programs in the use of computers supported by state university systems and local colleges should be implemented. These in-services should be of a general to specific nature and cover elementary through secondary level uses of hardware and software for mathematics and science.
2) Requirements at the initial teacher training level (higher education) that each pre-service teacher be not only "computer literate" but, computer functional should be implemented. By computer functional, it is meant that the individual knows how to sucessfully run and teach, normal educational programs, such as word processing, data base, and desk top publishing programs.
3) School systems should support computer use in the home by surveying student populations. This would make possible the purchase or production of educational software that could be made available through the school library system.
4) State computer programs should review their software offerings to include more than drill and practice programs. In interviewing students and observing the IMPAC laboratories in use, it was noticed that the software available was, in general, all of the drill and practice variety. The present study has shown that this type of software is the least efficient in effecting student achievement and attitude.
5) Libraries in the elementary, middle schools, and high schools in Arkansas should have computers installed with a selection of software for student use in both report writing, research, and strategic simulation software such as that found in best selling software lists available from many of the commercial resellers. Telecommunications (modems) hooked to these computers would put the particular library in touch with the world and would allow interested students to access major data bases. This particular use of computers would allow students in rural locations to gain a more global outlook.

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A Content Analysis of Technology Coverage in Teacher Education Books

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Abstract

Examining the books that are available to preservice teachers may provide an insight into why teachers have not been incorporating technology in their classrooms. This study examined 15 books generally available to preservice teachers. The results revealed an inadequate coverage of technology related issues in introduction to teacher education and educational psychology textbooks and scholarly teacher education books.

Introduction

Although technology use is growing at a rapid rate in government, science, medicine, law, business, and family life, its use appears to have grown only slightly in the area of education (Zappone, 1991). Education, and in particular teacher education, has not kept pace with other fields in its integration and use of technology (Heinich, 1985). In a 1988 survey by the U. S. Office of Technology Assessment, for example, only half of the teachers surveyed responded that they had ever used a computer. There is little question that preparing future teachers to use technology is a concern of preservice teacher educators. Teacher education programs should provide preservice teachers with the understanding that will enable them to prepare all their students to keep pace with technology.

Perhaps the reason that teachers have been slow in integrating technology in schools has been because few teacher education programs provide a computer-intensive curriculum (Brownell, 1990; Marshall & Pfeiffer, 1984). For example, although computer courses are a part of over 50% of teacher education programs, generally these courses are introductory courses in computer education (Teacher Preparation in the Use of Computers, 1986). Effective use of technology may require changes in the curriculum in teacher education programs. Teachers' level of computer knowledge may be improved by integrating technology into the curriculum of teacher preparation programs (Norvak & Berger, 1991) rather than having technology viewed as an add-on (Zappone, 1991).

Textbooks generally influence how curriculum is organized and subsequently how students view the content being presented. Since textbooks play such a very critical role in teaching, it is important to examine the books used in training preservice teachers. For example, 75-95% of classroom instruction has been found to be based on commercially prepared materials (Komoski, 1985; Squire, 1988). Examining the books that are available to preservice teachers may provide an insight into why teachers have not been incorporating technology in their classrooms.

The purpose of the present study was to examined several recent (i.e., 1987-1992) books available to preservice teachers. Introductory education textbooks, introductory educational psychology textbooks, and teacher education scholarly books were reviewed. A content analysis was conducted to determine the educational purposes of technology presented in the book. Specifically, the analysis will provide a list of topics pertaining to technology that were addressed in these books.

Method

Sources

A representative sample of ten textbooks—five introductory education texts and five educational psychology texts were examined in the present study. All texts met the following selection criteria: (a) published within the past five years, (b) over 400 pages in length, and (c) available from major a publishing companies. These textbooks vary in degree of utilization in teacher education programs with some being fourth and fifth editions of the most widely used textbooks in the field (e.g., Ryan & Cooper, 1988; Woolfolk, 1990), while others are first editions that have not yet been widely adopted (e.g., Gibson & Chandler, 1988; Arends, 1988).

Five scholarly books in the area of teacher education were also included. The scholarly books were all edited volumes of at least 300 pages in length. These texts dealt with research and/or knowledge that preservice teachers need to know in order to improve classroom practice. Although these books are generally not used as texts in preservice teacher education courses, they all specifically focus on the research and knowledge base (i.e., synthesis of research knowledge in the area of teaching and teacher education) that is most often used and cited by teacher education faculty. These books also vary somewhat in their degree of coverage, with some attempting to be comprehensive of the field of teacher education (e.g., Dunkin, 1987; Houston, 1990); while others focus on knowledge essential for all teachers (e.g., Richardson-Koehler, 1987; Reynolds, 1989).

Procedures

The method used to determine the extent to which technology is presented in the texts selected was as follows. The procedure included initially examining the

Table 1
Summary of Technology Coverage in Teacher Education Books

Introductory Education Textbooks	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	%
Textbook 1	X	X	X	X	X	X		X	X		X	X				1
Textbook 2				X		X	X			X	X				X	4
Textbook 3		X	X	X	X	X	X	X	X	X		X				5
Textbook 4		X	X	X	X	X	X	X	X	X		X				6
Textbook 5	X	X	X	X	X	X	X	X	X		X	X				3
Introductory Educational Psychology Textbooks																
Textbook 6		X	X							X	X		X	X		2
Textbook 7	X	X	X	X	X			X			X		X		X	3
Textbook 8																0
Textbook 9		X	X	X	X											1
Textbook 10		X		X	X	X										2
Scholarly Teacher Education Books																
Book 11		X			X	X	X	X			X	X				1
Book 12		X		X	X		X	X					X	X		1
Book 13															X	1
Book 14	X	X	X		X	X	X						X		X	1
Book 15	X	X	X	X	X	X					X				X	5

Key I = Software J = Other Technological Aids C = Programming K = Instructional Benefits D = Computer literacy; L = Social Benefits M=Restructuring teacher roles N=Technology and Special Needs Students O=Restructuring classrooms P=Cost Factors Q=Restructuring schools R=Hardware text

table of content and index for key terms. This was followed by further careful examination of the text. The text was read and a lists of topics addressed pertaining to technology was compiled. In order for a topic to be coded, the text had to provide sufficient detail to give the reader an opportunity to gain a conceptual and/or factual understanding of technology. A mere mention of topic did not warrant coding. For example, if the text stated "Computer courses should be included in the curriculum", this would not be considered as providing sufficient detail.

The introductory textbooks were designated as Textbooks 1-10. The scholarly texts were labeled Books 11-15. Textbooks 1-5 fall under the category of introductory teacher education textbooks. Textbooks 6-10 are introductory educational psychology textbooks. Complete references of textbooks and books used in this analysis are available from the author.

Results

The goal of this study was to determine the integration of technology in teacher preparation textbooks and scholarly teacher education books by examining textbooks and books that are generally available to preservice teachers. Topics identified in the textbooks and books included: (a) using computers to perform functions such as word processing, data analysis (Tool); (b) using computers for drill practice exercises, tutorials, and simulations (Computer-based Instruction); (c) providing information on students programming computers and examples of common programming languages such as LOGO, PASCAL and BASIC (Programming); (d) providing information on how computers work and the role of computers in society (Computer Literacy); (e) using technology for managing classroom information such as schedules, record-keeping, compiling test items, grading, planning (Restructuring Teacher Roles); (f) changing the current structure of classrooms by incorporating technology for instructional purposes (Restructuring classrooms); (g) explaining the need of incorporating computers throughout the school environment in order to respond to changes in society and using technology in the school for such tasks as monitoring attendance and record keeping (Restructuring Schools); (h) discussing hardware such as video tapes; videodiscs (Hardware). (i) providing guidelines for selecting and evaluating software and examples of programs available (Software); (j) providing examples of other instructional aids such as television, film, filmstrips, overhead projectors, chalkboard (Other Technological Aids); (k) discussing the instructional benefits of technology in promoting students' academic achievement (Instructional Benefits); (l) explaining the social benefits that the use of computers can provide such as increased social interaction (Social Benefits); (m) using technology with students who have special needs (Technology and Special Needs Students); (n) addressing the high cost of incorporating technology in classrooms and the school (Cost); and (o) addressing disadvantages that the use of technology may present. For example, there may be unequal access to computers by disadvantaged or minority students; technology may create an elitist society, since not all schools may not have sufficient access to computers, gender issues in computer usage (Disadvantages). In addition, the actual amount of technology coverage in the book is reported as a percentage. The percentage was calculated using the total number of pages the topic was discussed in each book and the total number of pages in the book. It should be noted that all textbooks and books discussed the use of microcomputers. Table 1 reports the results for all the texts examined.

The following topics were cited most often in all textbooks and books: (a) Computer-based Instruction, (b) Programming, (c) Computer Literacy. A topic that was also frequently mentioned was the need of restructuring teacher roles by incorporating technology in a variety of managerial and instructional tasks. On the other hand, there was little discussion of the instructional benefits of technology on students' academic achievement, the use of technology with students of special needs, such as handicapped students. Only one book (Textbook 6) cited cost as a factor in the use of technology. In addition, the results revealed that very little discussion of technology was included in most of the scholarly books and textbooks. The coverage of technology in all books reviewed ranged from 0% to 6% of the total text. Introductory teacher education textbooks included the greatest coverage with an average of 3.8% coverage for all books in the category. Scholarly teacher education books followed with an average for all the texts of 1.8%. Introductory educational psychology textbooks incorporated information about technology the least (1.6%). Overall, when technology was discussed, it often merely referred to computer-assisted instruction programs. There was very little discussion of computer-enriched classrooms or more advanced technological innovations like interactive video instruction.

Conclusions

Although some teacher education programs have begun to effectively incorporate technology training in their courses (see, e.g., Nelson, Andris, & Keefe, 1991; Norvak & Berger, 1991), there is evidence that teachers have not integrated technology into their classrooms. In order for teachers to meet the challenges of the technological age teachers will need to be provided with instructional materials that develop and provide practice that leads to the acquisition of the necessary skills. There is also a need to study the contents of teacher preparation texts, given that these play an important role in teacher preparation. The present study, reveals that there is an inadequate amount of coverage of technology related issues in the textbooks and scholarly teacher education books contained in this sample.

The present study provides insight into why teachers may not be integrating technology in their classrooms. Nonetheless, this study is limited in that only five books from each area was chosen. The consistency within and across categories, however, suggests that the present study's findings may be generalizable.

The use of technology should be a part of teacher preparation courses across the curriculum. Overall, this analysis indicates that textbooks are woefully inadequate in providing such opportunities. Simply providing a course in computer literacy is not sufficient to insure computer applications are integrated into the curriculum (Nelson, et al., 1991). Preservice teachers should be exposed to the benefits of integrating technology in the classroom and different approaches for effectively implementing technology. Furthermore, teachers should be aware of the wide range of software available for themselves and their students as well as the wider variety of hardware and technological advances available today. If a computer intensive approach to teacher education is used, our students may be more likely to adopt such an approach when they become educators.

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MATHEMATICS & SCIENCE

There are some differences in the types of papers presented at the 1992 Technology and Teacher Education Conference when compared to the 1991 Conference. Significant shifts include (a) more attention to calculators as a technology for mathematics instruction, (b) more empirical evidence (both quantitative and qualitative) presented as documentation of projects' effects, and (c) almost unanimous attention to the notion that learners must construct their own understanding of the uses of technology in mathematics and science instruction (i.e., "constructivism"). Perhaps the most critical unaddressed question is how to have impact on the thousands of teachers who should know about using technologies in teaching mathematics and science.

There are several interesting shifts in the substance of mathematics and science education papers presented at the 1992 Technology and Teacher Education Conference as compared to the 1991 Conference. One is that there is more attention this year to calculators as a technology that must be incorporated into mathematics instruction. I personally believe that this is an important and appropriate shift, since calculators are becoming not only much more powerful (i.e., much more like computers) but also less expensive. It is now possible to provide teachers with a classroom set of very powerful calculators for less than the cost of one decent computer system; further increases in power and decreases in cost seem quite likely in the near future.

Second, there is more empirical evidence (both quantitative and qualitative) presented this year as documentation of the effects of programs. Although it is usually not difficult to obtain testimonials to the success of a program, there has often been little objective evidence that inservice and preservice programs are widely effective. Without such objective evidence, it may be difficult to convince policy makers to implement those programs. Hopefully, the new evidence will help us all understand what additional alterations in programs are needed to provide even more effective education to mathematics and science teachers.

Third, and I think most significant, almost all of the mathematics and science papers take the explicit position that teachers and students need to construct their own understanding about the uses of technology in mathematics and science instruction. This shift to "constructivism" represents a critical reconceptualization of our knowledge about education; it is quite different from the more behaviorist views of the 1970s and early 1980s. In terms of integrating technology into teacher education, the shift suggests we must strive to find conceptual, rather than procedural, approaches for teaching about the use of technology to learn content. It is the learner (whether teacher or student) who determines the particular substance of what is actually learned. Our job as teacher

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educators is to support teachers as they incorporate knowledge about technology into their already rich cognitions about content and pedagogy.

Survey of the Papers

Dale S. Niederhauser and Trish Stoddart: ***Integrating Technology with Elementary Mathematics: Effects of Training and Support***

Niederhauser and Stoddart present evidence that suggests that the ways computers are used by teachers may affect not only teachers' practices but also their beliefs and attitudes. This suggestion is consistent with other literature on change, so in and of itself, it is not surprising. What seems critical are the differences between the inservice models that are compared. In one school, staff development was fairly direct, limited, and determined by outsiders. In the other school, staff development was far ranging, intensive, and mutually determined by the teachers and outside consultants; that is, a more constructivist approach to generation of knowledge about the use of computers in elementary mathematics. More knowledge of the basis on which the schools self-selected for the two particular uses of computers would have been useful. Did the teachers vote on the choices? Did the principals dictate the choices? Did a central administration official assign the choices? Interesting questions are whether the two inservice experiences could (or even should) have been used in the opposite sites and what the effects of reversing these staff development approaches might have been. To the extent that this study constitutes an "existence proof" of ways to change teachers who are ready to change (that is, teachers who self-select a particular style of experimentation with computer tools), it is very interesting work. However, it does not address the potentially more important question of how to get the "typical" teacher ready to teach differently or even to use computers.

Susan E. Williams, Juanita V. Copley, Shwu-Yong L. Huang, and George W. Bright: ***Effect of Teacher Involvement in Curriculum Development on the Implementation of Calculators***

Williams, Copley, Huang, and Bright document that middle school teachers who help develop instructional materials involving calculators use calculators differently in instruction than teachers who received inservice on the calculators but who did not write instructional materials. The teachers who are involved in the project are at least partially self-selected, however, so there is no way to know if the "typical" middle school teacher might respond similarly to participation in writing activities. Too, it seems reasonable to assume that the materials-development activity had the effect of involving the experimental teachers more deeply in learning about the calculators (i.e., in constructing their own knowledge about uses of calculators) than did the inservice activity for the control teachers. The differences in calculator use in classrooms might reflect that deeper involvement. Unanswered is whether there are inservice strategies that might create the same, deep level of involvement, without asking teachers to create new instructional materials. This report also points to the value of having systematic observation of teachers as they incorporate technology in their teaching. Although that is a somewhat expensive way to assess effects, it is one that probably ought to be used more frequently.

George W. Bright and Anita H. Bowman: ***Integrating Computers into K-12 Mathematics: Theoretical Considerations and Initial Attempts***

Bright and Bowman document that at the start of their project, participating teachers did not expect that the essence of mathematics instruction would be significantly altered by integration of computers. Rather, the teachers expected that computer use would further traditional goals and objectives. Evidence is also provided that teachers' engagement in analysis of software is slow in developing. Yet, even with very preliminary data, some change is already detectable. Perhaps even more important, the participation teachers immediately recognized, and seem somewhat surprised, that they can learn significant lessons from teachers at very different grade levels (i.e., they worked across grade levels to construct knowledge about computers and about the sequencing of mathematics concepts). Yet like most other projects dealing with technology, the teachers are self-selecting, and this project may not be able to uncover general principles for helping "typical" teachers learn how to integrate computers into instruction.

Janet L Johnson, Lee V. Stiff, and Sarah B. Berenson: ***Using Symbolic Calculators to Facilitate Constructivist Learning in mathematics of Finance***

Johnson, Stiff, and Berenson address constructivist learning, but at the university level. Technology seems to have played a significant role by providing the necessary computational power to "free up" the instructional time necessary for discussion and exploration to occur. In particular, the students in the technology-supported classes were engaged with the content in different ways (e.g., asked more higher-level questions) than students in the traditional classes; that is, the technology-supported students were able to focus on ideas instead of only computations. Technology-supported students also improved more in terms of their attitudes about the simplicity of mathematics and about locus of control.

These results support the notion that technology can really change the nature of learning.

Robert J. Lindahl: **Applications of the Graphics Calculator Related to Discrete Mathematics**

Lindahl presents several examples of ways that graphics calculators can be used to investigate concepts in discrete mathematics. These examples are consistent with a constructivist approach to teaching. When viewed along side the results of Johnson, et al., these examples may help inspire examples for other types of courses. Indeed, many more such examples, for the full range of mathematics courses, need to be developed to provide an adequate body of information about appropriate uses of technology in teaching mathematics and science.

Ronald Cosby and Thomas Jordan: **Computer Graphics, Spreadsheets, and Expert Systems Workshop for Physics Teachers**

Cosby and Jordan describe a summer institute that helped make secondary teachers more proficient at using plotting and spreadsheet software personally, more active in demonstrating physics concepts, and more aware of instructional applications of expert systems. Evidence of the success of this institute came mainly from informal evaluation of the participants' completed projects. Clearly, the teachers were excited about their new knowledge of technologies.

Kenneth F. Clark: **Graphical display of Quantitative Data Using a Microcomputer**

Clark presents some general guidelines for presentation of data displays. Some of the guidelines reflect "common sense" but some arise from more technical concerns. Users of graphing calculators and computer graphing tools would be well advised to attend to these guidelines when planning teacher inservice sessions. The technological limits of those technologies may sometimes be in conflict with these guidelines, and users need to decide how to adjust instruction when such conflicts occur.

Bill Yates and Harvey C. Foyle: **Cooperative Learning and Science Databases**

Yates and Foyle make a case that the use of databases will help science students develop understanding not only of important concepts but also processes for learning science. One of the keys to this development is that students get hands-on experience with sorting and re-sorting the databases. That is, students need to use databases as a tool for construction of science knowledge. More examples of this type need to be generated and published in order to create a critical mass of ideas that teachers can use.

Looking Ahead

The inservice projects represented in these papers each involved only a small number of teachers. These projects, therefore, stand only as models of what can be done. Other approaches are certainly possible and need to be investigated. Perhaps the most critical unaddressed question is how to impact the thousands of teachers who need to know about using technologies in teaching mathematics and science. If the intensive approaches represented by these projects could be combined with projects like the statewide effort reported last year (Bright, 1991), we might be able to impact very large numbers of students. This would be a significant step toward changing the nature of instruction in mathematics and science (e.g., National Council of Teachers of Mathematics, 1989, 1991).

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Integrating Technology with Elementary Mathematics: Effects of Training and Support

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Abstract

Case studies of two public elementary schools help demonstrate differences between how teachers have implemented computer-assisted mathematics instruction in classrooms. The two schools have differing views about how technology can be used most effectively for mathematics instruction; they have adopted different computer software programs as well as different approaches to staff development. Discussion is presented on how these different approaches have influenced teachers perspectives about mathematics instruction, the role of computers in instruction, and the impact of computers on classroom practice.

The introduction of technology into the public schools is currently viewed as an important force for restructuring and improving teaching and learning in U.S, classrooms (Gifford, 1986). Large amounts of public and private sector money are being invested to provide advanced technology to the public schools (Office of Technology Assessment, 1988). It has been predicted that within the next five years microcomputers will be routinely used in most classrooms across a wide range of the curriculum (Newman, 1990). To date, however, this massive investment of resources has not resulted in significant changes in instructional practice or increases in student achievement. The use of microcomputers in classrooms has typically resulted in the same kinds of teacher-directed "show and tell" approaches to instruction that have dominated classrooms throughout this century (Cohen, 1989; Goodlad, 1984). For the most part, teachers appropriate the new technology into their existing practice and focus on using microcomputers for the acquisition of basic skills using drill and practice (Bork, 1980; Cole & Griffin, 1987).

Part of the problem is that most funding is allocated for the purchase of computer hardware and software, with very little funding available for staff development and classroom support. It is commonly assumed that if teachers are provided with innovative technology and receive basic training in operating computers, they will effectively integrate it into their classroom practice (Shulman, 1986). In addition, school faculty and administrators, who typically know little about computer assisted instruction, are frequently asked to make decisions about the purchase of computer hardware and software systems. If computer assisted instruction is to be effectively utilized in classrooms we must develop a better understanding of the implementation process. This paper analyzes the cases of two schools as faculty begin to implement substantively different computer systems in their daily mathematics instruction.

The Study

The two elementary schools in the study received grants through the State Educational Technology Initiative to purchase computer hardware and software systems. School A has purchased Tandy computers and housed three machines in each classroom. They also purchased the Wasatch Education System (WES) software package, an integrated learning system. The vendor company provided fourteen days of staff development activity over the course of the first year. School B purchased IBM computers and placed five computers in each classroom and 18 computers in a lab. IBM provided 5 days of technical training to help teachers learn to operate the computers. In addition, school B faculty initiated a collaborative staff development project with mathematics educators from a local university. Two university faculty and one graduate student worked with teachers in the implementation of conceptually-based mathematics curriculum with integrated computers. The university personnel provided ongoing staff development and worked with teachers in their classrooms. The two differences between the schools that this study addresses are: (a) computer software: an Integrated Learning System (ILS) approach *versus* a tool-based approach, and (b) staff development: vendor-supplied training for an ILS presented in isolation from the classroom *versus* ongoing classroom-based staff development and support.

School A: Integrated Learning Systems

School A chose to implement an Integrated Learning System. There are several reasons why many schools choose an ILS. First, an ILS is a complete package that includes the software, teacher manuals and student workbooks teachers need to begin using the computer system with students. In addition, ILS software is often keyed to State curricula and/or standardized tests that teachers see as a link between ILS instruction and improved test scores for students.

With an ILS, students work through computer activities in a sequential fashion with early activities laying the foundation for later activities. Instruction consists of the computer posing problems (in a tutorial and/or drill and practice format) that students try to solve. Using computers in this way fits well with the traditional public school curriculum in which teachers and workbooks pose problems to students.

An additional feature of an ILS is a record-keeping system that tracks student progress. This feature enables teachers to monitor student learning and produce progress reports that can be sent home to parents. With this information, teachers can address issues associated with accountability for student learning.

The ILS package often includes a service agreement that provides maintenance of the hardware for a specified period of time and some form of inservice training for teachers who will use system. Essentially, the entire ILS package is complete and it does not take a great deal of expertise on the part of teachers to use computers and ILS software as teaching machines.

School B: A tool-based system

The faculty of School B took steps to use technology to change the way they taught mathematics. They wanted to develop a conceptually-based mathematics curriculum that integrated "hands-on" learning with computer use. As a result, they approached mathematics educators at the local university and asked for their assistance. These mathematics educators recommended that the school use a program called *ToolBook* (Asymetrix Corporation, 1989) in their mathematics instruction and committed to work with the teachers in their classrooms to help them learn this approach to teaching mathematics. This program is a flexible, open-ended tool that allows students to graphically represent problems and solutions. In this approach, the teacher begins by posing problems for the students to solve. Students develop mathematical knowledge by struggling to understand the problems using concrete materials. They then model their solutions using the computer. When students have worked through some teacher-presented problems, they begin to formulate and solve their own problems to further develop and enhance their understanding. Students are able to represent their individual models of understanding using the *ToolBook* program. With this type of mathematics instruction, the focus is on reasoning through a process rather than gaining procedural and/or factual knowledge.

Method

Subjects

The subjects included 16 elementary school teachers in grades K through 6 drawn from two inner-city public elementary schools.

Interview

This study utilizes an adaptation of the National Center for Research on Teacher Education elementary mathematics interview (Ball & McDiarmid, 1988; NCRTE, 1988). The interview was developed to assess elementary teachers' pedagogical knowledge and skills for teaching mathematics and has been adapted to include information about microcomputer-based instruction. The interview focuses on teachers': (a) perspectives of mathematics as a discipline, (b) pedagogical approaches to teaching mathematics, (c) beliefs about how computers can be used to teach mathematics, and (d) satisfaction with using computers to teach mathematics. Initial interviews were conducted before microcomputers were installed in classrooms. The second round of interviews took place in the middle of the school year. School A had been using the computers, primarily for keyboarding exercises, for a year, but both schools had been using the computers for systematic mathematics instruction for approximately 5 months.

Analysis

Transcribed interviews were read by both researchers. Themes were identified and refined through a process of discussion and rereading of the transcripts. When themes had been established, transcripts were coded and categorized using a word processor.

Results

Baseline

In pre-technology interviews, there was remarkable homogeneity between the teachers with regards to their perspectives on using computers to teach mathematics. The primary theme that emerged from these interviews was the hope that the computer could be used to help teach mathematics more effectively. A second grade teacher expressed the feelings of most when she said, "Well mostly I've seen them used for drill types of things, but I'm understanding and hoping that this will be just the opposite, you know, students will learn the process." Teachers felt this could be achieved through the computer presenting graphic representations of the problems allowing students to "visualize" mathematical concepts. In talking about division with fractions, teachers said: "I think the computer could show it in a picture quickly and divide it up and the child could really see it happening," and "I think it would show them things to begin with, pictures right there of things and they could see it visually", and "I think the computer can do it graphically the kids could pick up the one half and match it over each little section, so they could ideally create their own problem and draw their own picture and illustrate this." Another teacher thought the computer could help with story problems, "Here again they could have a picture of what is going on. Perhaps the picture is there to begin with, you know, with story problems they could actually show this happening and then with the written word, then after awhile I think it would help the child to do their own picturing in their mind of what they see happening on the computer."

Staff Development Experiences

There were clear differences between the two schools with regards to teachers' experiences in attempting to integrate the computers into mathematics instruction. Teachers also differed in the perspectives they developed about how computers could be effectively used in mathematics instruction.

In school A, Wasatch Education Systems provided the equivalent of fourteen days of inservice training. The training consisted of 1/2 day and 1 to 2 hour sessions. These sessions included information about how to use the computer, how to manage using computers in the classroom and the content of the WES software. Some teachers had no previous experience with computers, consequently, initial instruction focused on how to operate the machines. The remaining sessions addressed how to manage the use of computers in the classroom: "rotate children through and how to give directions", and get a sense of the content of the courseware: "We previewed software a lot of different times." The school's technology coordinator characterized this as "lock-stepping the teachers through the programs."

In school B, three university mathematics educators spent five days training teachers in a constructivist approach to mathematics teaching that incorporates many of the principles proposed by the National Council of Mathematics Teachers (1989). The mathematics educators also co-taught in classrooms with individual teachers to help them integrate the new method into their mathematics instruction. The instructional program has three steps: (a) use of physical "hands on" materials to construct representations of problems and solutions, (b) use of graphic materials and models to construct problem representations and solutions, and (c) use of computer simulations via programming to construct problem representations and solutions (Peck, 1989; Peck & Connell, 1991).

The goal of this teacher training was to assist teachers in helping their students move from routine applications of procedures towards problem solving strategies including identification and selection of data, problem goals and verification. It was hoped that students would begin to "think like mathematicians." An explicit objective was to help each teacher empower their students to figure problems out for themselves.

In the baseline interviews, teachers had expressed the belief that computers can compensate for instructors' lack of knowledge in mathematics and develop representations that would help students understand the concepts. In school A, teachers often introduced new concepts by presenting them with the computer. Teachers said "I can do presentations on the T.V. screen with any software." and "Starting long division. I do it with a computer program and show the children because it is right on the screen." These teachers used the computer to present the mathematics content. Another teacher used a tutorial to teach algebra. The only exposure to algebra that these students got came from the computer "Computers can explain things I don't have time to explain and in a different way." In this case, the computer was replacing the teacher.

These teachers also saw the computers as a means to provide opportunities for students to get practice. Teachers said "The computer is a tool for practice." and "They like to practice SRA [the drill and practice program]. SRA just pops up questions in a sequence from easy to hard. Not telling how [to do them], just drill." Teachers felt it was too early to see tangible results about whether students had changed the way they understand mathematics. Teachers said "We've just started. It is too early to tell." and "As far as long range impact it is too early to tell."

In school B, teachers found that implementing the new method required that students understand the mathematics sufficiently well to construct the representations themselves. The teachers soon realized that they, as teachers, needed substantial understanding of mathematical concepts to teach this way. Teachers felt very uncomfortable with the fact that the students picked up both the concepts and procedures more quickly than they did. For example, one teacher said: "I see these kids being faster with what he's doing than I am. When they explain it to me I can see they're correct and can understand what they're doing, but they're quicker than I am. I'm a little uncomfortable. Because if they say 'Mr. Brown, is this right?,' hopefully I can figure it out by the time that they finish explaining. But it makes me feel uncomfortable."

This discomfort reached a peak about the fifth week of the co-teaching activities. Teachers could see students responding to the new instructional methods but wanted to be more actively involved in the instruction themselves. To do so, however, the teachers needed a much better understanding of both the mathematics and computer processes. The mathematics educators responded by spending more time teaching teachers and less time modeling the instruction with students.

The co-teaching was a critical factor in keeping the teachers engaged in the project. Teachers tend to judge innovative instructional practices by their effect on students (Guskey, 1986). In this particular situation the students were highly motivated by the new methods. One teacher said that his students now "felt smart at math ... they felt like they were learning." Teachers were impressed at the kinds of mathematical representations students developed and their ability to program the computer to solve problems. They were convinced that this method was effective despite their difficulties in applying it. It is very likely that without the co-teaching—which allowed teachers to directly observe the impact of the method on the students—the project would have failed.

Some of the teachers' beliefs about how computers could help them in their teaching changed as well. Teachers in school A had incorporated the technology into their practice as a presentation device and means of providing practice. Thus, the computers were taking some of the responsibility for teaching the students. However, these teachers saw little improvement in their students mathematics abilities that related to using the computers. As one teacher put it "Well, it's the same. It's the same math."

Teachers in school B recognized that the computer could not replace or compensate for their lack of knowledge and skill. To effectively integrate the computers into their mathematics instruction they would need to put forth the effort to better understand mathematics themselves. These teachers noticed substantial differences in the ways their students understood and thought about mathematics.

Discussion

The teachers in this study, like many elementary school teachers, are not adequately prepared to teach mathematics (Ball, 1990; Stoddart, Connell, Peck & Stofflet, 1991). They have experienced difficulties in learning mathematics themselves and in developing mathematical understanding in students. As the baseline data indicates, these teachers hoped computers could help them become more effective mathematics teachers. They seemed to believe that there was a better use of technology than the standard drill and practice type of programs, but they were not clear about what this might be. The teachers' perceptions of how computers might help students understand mathematics appear to be related to their views that students who are good at math can visualize problems. They saw the computer as a tool to help present mathematical concepts graphically.

Initially, all of the teachers saw the computers as a presentation tool. They believed the computer could present the information better and more clearly than they could. In the second round of interviews, it became clear that although teachers from school A were, in fact, using the computers to present information, teachers in school B had shifted their pedagogical understandings and no longer viewed mathematics instruction as teachers presenting visual representations to students. In school B, computers were used for students to model and represent their mathematical understandings for themselves, their peers and their teachers.

A related issue focuses on teachers' expectations. When these expectations are not met teachers are likely to become disaffected with a staff development project. Teachers are motivated to engage in staff development projects because they want to become better teachers (Guskey, 1986). McLaughlin (1990) suggests that in the majority of cases teachers only see an instructional innovation as valuable after they see changes in learner outcomes. It may be that it was only because of the gains that students were making in their mathematical understandings that teachers in school B continued in the program. Without the modeling and support from the

University faculty, there would have been little chance for success.

Another issue that arises in this study involves the ease with which the instructional technology can be assimilated into the existing classroom practice. The teachers who adopted an ILS were able to incorporate the computer into their instructional program easily. They used the computer in two principal ways: (a) to present information to the whole class in a lecture/demonstration format, and (b) as a teaching machine to engage individual students in drill and practice.

For these teachers, the introduction of computers meant business as usual. There was little change in their beliefs or instructional practice and they saw little improvement in their student's mathematical abilities.

The situation was quite different for the teachers in school B. Instead of serving as a time-saving aid for teachers, the introduction of the computer made significant demands on them in terms of time and effort. The new approach required radical shifts in their understandings of mathematics, of computers and of teaching. There were times when teachers felt inadequate because of their lack of knowledge and skill. These teachers were able to change their views concerning the role of computers in instruction and their role as teachers. They see the potential of computers in developing students' conceptual understandings. They also recognize the need to improve their own knowledge and skills in order to capitalize on this potential.

In conclusion, this preliminary study indicates that tool-based systems have significant potential in changing the way teachers teach. They are, however, extremely difficult to put into place and require a great deal of teacher education and support. Integrated Learning Systems, on the other hand, are easy to install, simple for teachers to use and fit right in with standard practice, yet they have limited potential for changing teachers beliefs and practice or upgrading instruction.

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Effect of Teacher Involvement in Curriculum Development on the Implementation of Calculators

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Abstract

The integration of technology and mathematics instruction has been advocated by researchers and other leaders of the mathematics community for the past two decades. Numerous studies have shown that calculators are not detrimental to student retention of basic skills, and gains in problem solving are evident. Activities have been developed to assist the teacher, but actual implementation of the technology has been extremely slow. Research in curriculum development without technology suggests that implementation of innovative changes often results in disappointing outcomes when teachers are not involved in the development of the innovation. The purpose of this study was to determine if there are differences in the classroom implementation of calculators between teachers involved in the writing of calculator curriculum and those merely provided the technology and the developed activities.

In mathematics education, research has stressed the need to "recontextualize" the curriculum, to use calculator and computer technology as tools of this recontextualization process, and to integrate the use of technology into the curriculum (Cole & Griffin, 1987). While technology tools have been widely discussed and unconditionally supported for students in all grade levels by professional organizations such as the National Council of Teachers (NCTM), the Mathematical Association of America, Mathematical Sciences Education Board, National Academy of Sciences, and the American Association for the Advancement of Science, the innovations of technology have not been widely implemented into the curriculum.

Several studies have examined curriculum development and implementation and found that innovations may result in disappointing outcomes, not because of inadequacies of the innovative idea, but because of the lack of teacher involvement in the development of the innovation (Berman & McLaughlin, 1976; Charters & Pellegrin, 1976; Stein & Wang, 1988; Strathe & Hatcher, 1986). Participation in the development of curriculum offers teachers a role in the shaping of educational programs, a sense of involvement and responsibility in the implementation process, and a commitment to the continued success of the program (McAtee, 1979; Morin, 1986; Rothman, 1988; Young, 1985). Sarason (1982) determined that the more committed groups are to a proposed change, the more likely the goals of change will be approximated. Authoritarian decision-making forces can effect simple or "cosmetic" short-term changes, but participative structures are needed to promote real change (Fullan, 1982; Sikorski, Turnbull, Thorn, & Bell, 1976). Berman and McLaughlin (1975), for example, found that the continued effect of change seemed to be related to the process of curriculum development involvement rather than in the relative quality of materials developed.

The purpose of the present study was to investigate the effect of teacher involvement in the curriculum development of calculator materials on the implementation of calculators in the classroom. The investigation compared the implementation process of two groups: (a) teachers who only received in-service training on calculator implementation and (b) teachers who received in-service training on the implementation of calculators and were members of a writing team that developed the calculator curriculum.

Methods

The subjects in the present study were 44 middle-school (i.e., grades 6, 7, and 8) mathematics teachers from a large, urban/suburban school district located in a major metropolitan city in the South Central Region of the United States. All the middle school mathematics teachers in the District received a minimum of 12 hours of in-service training on the use of calculators during the fall semester and each of the 6800 middle school students in the District was issued a calculator at the beginning of the spring semester.

The experimental group consisted of teachers who were selected by the school district to be curriculum writers. These teachers were released from their classroom teaching assignments a half day, once a month for eight months during the school year. These teachers worked with mathematics educators from a nearby College of Education in developing a set of mathematical explorations that required the use of a calculator. The developed explorations contained problems posed in a contextual framework, questions that encouraged a variety of explorations with the calculator, and suggestions of possible activities and extensions. In addition, the developed explorations were correlated with the existing curriculum and the *Curriculum and Evaluation Standards. for School Mathematics* (NCTM, 1989).

The control group consisted of 22 teachers randomly chosen from the remaining middle school mathematics teachers in the district. Although the control group did receive 12 hours of training on how to implement the calculator in their classrooms, it was hypothesized that they would not implement it as much nor as well as the curriculum writers who were developing lessons and examining how the technology could be appropriately integrated in the existing curriculum.

Each experimental and control teacher was observed four times during the spring school semester by trained classroom observers. Teachers had no indication as to when they would be observed. Two observations were completed for each teacher during February and early March; two additional observations for each were performed in April and early May. A modified version of the Classroom Rating Scale (Waxman, et al., 1983) was used to measure the amount of calculator instruction that was observed in each classroom and to assess the quality of the calculator instruction. Seventeen indicators were used to measure the quantity and quality of calculator instruction. The inter-rater reliability for the instrument was greater than 0.90.

Results

Overall, three findings revealed that there were significant differences between the experimental and control groups on the amount of time calculators were used in the classroom (Table 1). The most exciting of these results is that teachers in the experimental group were observed stressing the use of calculators as "problem-solving tools" 51% of the time as contrasted to 22% of the time by teachers in the control group. Much emphasis was placed on using the calculator as a "problem-solving tool" during the calculator training that all District middle-school mathematics teachers received. The teachers in the experimental group who wrote curriculum each month used problem solving as their focus for the explorations that they developed.

Other significant findings between the two groups included students using calculators for computational purposes which was observed almost 90% of the time in classes of the experimental group and 66% of the time in control group classrooms. The third significant difference related to students' use of the calculator for solving routine word problems. In the experimental group, the calculators were used for this purpose 35% of the time as opposed to 14% of the time by the control group. Although not a significant finding, teacher initiation of use of calculator approached significance ($p < 0.07$). The control group suggested that students use a calculator 59% of the time as opposed to 81% of the time by the experimental group.

Although all middle-school students in the District were individually issued a calculator, there was no guarantee that the students would bring the calculators to class each day nor that the teachers would provide opportunities for the students to use them. The results of the four observations indicate that for the spring semester 79% of the students of the experimental group and 68% of the students from the control group brought calculators to class. Also, the calculators were in use during those class periods approximately 70% of the time for both groups.

The descriptive data also reveal that the method of using the calculators was different in the control and experimental teachers' classrooms. In the control classrooms, students were allowed to determine the appropriate use of calculators about 47% of the time and to initiate use of the calculator 61% of the time, while students in the experimental classrooms determined the appropriate use about 55% of the time and initiated use about 66% of the time. Furthermore, in the control classrooms, teachers emphasized the importance of estimation for determining the reasonableness of a calculator answer only 22% of the time, explained the relationship between the calculator approach and the paper-and-pencil approach to a problem 30% of the time, and stressed the time-saving factor of the calculator 26% of the time. In the experimental classrooms, the percent of time spent by teachers emphasizing the importance of estimation was 33%, explaining the relationship between calculator and paper-and-pencil approach was 42%, and stressing the time-saving feature of calculators was 39%. In control classrooms, teachers demonstrated the use of a calculator 45% of the time and students used calculators during this time approximately 42% of the time. On the other hand, experimental group teachers demonstrated the use of a calculator during class time 50% of the time and encouraged students to participate with their calculators rather than just watch 54% of the time.

It is somewhat discouraging, however, to note that students used their calculators for exploration purposes only 18% (control) and 26% (experimental) of the time, for solving non-routine problems only 18% (control) and 26% (experimental) of the time, and for playing concept-reinforcement games 14% (control and experimental). Instead, calculators were used 51% (control) and 62% (experimental) of the time for self-checking and verification of answers. It should be pointed out that the standard deviations for all the items are quite large suggesting that there was a great deal of variance within both the experimental and control group classrooms.

Discussion

The use of calculator technology in mathematics instruction is widely encouraged by educators and researchers. Yet, as with any new innovation, effective change does not automatically occur simply because the technology or curriculum is made available to students and teachers in the classroom. The findings from this study suggest that teachers involved in the writing of curriculum requiring new technology use that technology more and in more effective ways. For example, there was more problem solving and the power of calculators was used more often (e.g., for computation and for routine problem solving). Too, the experimental teachers knew more about the calculators and seemed more able and

Table 1. Implementation of calculators in the classroom.

	Experimental		Control		
Survey Item	*m*	*SD*	*m*	*SD*	*t*
136. Allows students to determine appropriate use of calculator.	54.55	42.56	46.82	45.29	-0.58
137. Emphasizes importance of estimation to determine reasonableness of calculator answer.	33.41	39.44	22.27	31.61	-1.03
138. Explains relationship between calculator and paper-and-pencil algorithm.	41.59	43.08	30.45	38.60	-0.90
139. Stresses use of calculator as "time-saver".	38.64	42.91	26.36	35.53	-1.03
140. Stresses use of calculator as a problem-solving tool.	50.91	45.87	22.27	31.61	-2.41*
141. Teacher demonstrates use of calculator.	49.77	44.89	44.55	43.04	-0.39
142. Students use calculators during teacher demonstration.	53.86	45.20	41.59	43.08	-0.92
143. Student initiated use of calculator.	66.14	43.75	60.91	43.93	-0.40
144. Teacher initiated use of calculator.	81.36	35.19	59.09	45.87	-1.81
145. Students use calculators for computation.	89.55	26.77	66.14	43.75	-2.14*
146. Students use calculators for exploration/induction.	26.36	35.53	18.18	26.48	-0.87
147. Students use calculators for solving routine word problems.	34.55	41.03	14.09	19.19	-2.12*
148. Students use calculators for solving non-routine problems.	26.36	35.53	18.18	26.48	-0.87
149. Students use calculators for self-checking/verifying answers.	62.05	44.63	50.91	45.87	-0.82
150. Students use calculators for games.	14.09	19.19	14.09	19.19	0.00
151. Percentage of students who have calculators at their desks/tables.	79.09	23.69	68.18	33.19	-1.26
152. Amount of time students (who have calculators) use them.	68.18	33.19	70.00	33.81	0.18

NOTE: Experimental group (N=22) and Control group (N=22)
* $p < 0.05$

willing to suggest to students that calculators ought to be used.

The data also suggest that change occurs slowly even for those involved in curriculum writing. Further studies involving the long range implementation of developed curriculum by writers and non-writers, as well as other aspects of the implementation process need to be investigated.

Acknowledgements

Support for this research was provided in part by a grant from the U.S. Department of Education, Dwight D. Eisenhower Mathematics and Science Education Program (Grant No. R168D00311). Opinions and views expressed in this paper are those of the authors and do not necessarily reflect the positions of any government agency.

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Integrating Computers into K-12 Mathematics: Theoretical Considerations and Initial Attempts

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Abstract

This primary goal of this project is to help K-12 teachers from one elementary, one middle, and one high school in one district learn to integrate computers into mathematics instruction across all grades. A series of whole-day inservice workshops will be delivered during 1991-92 and fall 1992; general workshops will be presented to all teachers together and software specific workshops will be delivered to teachers in a particular grade range. A two-week workshop will be delivered in June 1992, so that teachers can concentrate on computer integration without the pressures of daily teaching. Part of the summer workshop will be devoted to development of student activities. The evaluation plan includes (a) surveys of teachers' understanding of specific software and of ways to use that software and (b) classroom observations to watch teachers use software in their own teaching.

The goal of this project is to help K-12 teachers integrate computers into mathematics instruction. Participating teachers are from an elementary, a middle, and a high school in a single district. The elementary school "feeds" the middle school, which in turn feeds the high school, so the project has the potential to make a significant impact on cohorts of students as they move from one school to the next. To achieve its goal, the project will deliver a series of inservice sessions to the K-12 teachers, both as a whole group and in grade level subgroups, and then will assist those teachers in preparing and delivering instruction to students. To assure that the content of the inservice sessions targets the needs of the teachers, periodic surveys will be conducted to assess the teachers' understanding of how to use specific software both to learn mathematics personally and to teach mathematics to students.

Need and Background

The focus of this project, the integration of computers into mathematics instruction, was chosen because the teachers of the three schools perceived that (a) computers were not being used adequately, (b) increased use of computers to teach mathematics has the potential for greatly improving students' understanding of mathematics concepts, and (c) teachers did not have a global understanding of how computers could fit consistently into the K-12 curriculum. Too, the teachers in the target schools believed that increased use of computers would help them deal with the multiple levels of understanding typical of students in most classrooms.

From a national perspective, there is a recognized need for better integration of computers in mathematics instruction. For example, shifts in content emphasis suggested by the *Curriculum and Evaluation Standards* *for Mathematics* and the *Professional Standards for Teaching Mathematics* (National Council of Teachers of Mathematics, 1989, 1991) not only highlight the use of computers as tools for supporting worthwhile mathematical tasks for students at a variety of levels of understanding but also suggest that education aimed at preparing students for the 21st century should include problem solving in computer environments. The *Professional Standards*, also addresses the need for teachers to create classroom environments in which discourse is encouraged and valued, both by teachers and by students. Computers not only encourage more extensive discourse, they virtually require it, since in most instances, software does not provide the option of providing a "paper trail" to use to reconstruct thinking. Students must talk about their problem solving processes, since there is no other way for an outsider to know what happened.

Teachers, at least as much as their students, need to experience the process of engaging in mathematics problems and then communicating about their problem solving processes. This is especially true when computer technology is thrown into the mix, because teachers (perhaps more than their students) are used to engaging in problem solving without the support of computers. When faced with the task of using computers to solve problems, teachers may find it difficult to adapt their problem solving skills to the new environment. Teachers, therefore, need time to learn how to make these adaptations in environments that are not confounded by the pressures of simultaneous delivery of instruction to students.

School Context

The minority distribution of students in the three participating schools is 41% minority in the elementary school (versus 37% for all district elementary schools), 40% minority in the middle school (versus 37% for all district middle schools), and 43% minority in the high school (versus 36% for all district high schools). Because the student population of the target schools is ethnically diverse, and because mathematics teachers in these buildings deal with many different groups of students each day, these schools provide an excellent context within which to address the needs of underrepresented groups. Current research (e.g., Cocking & Mestre, 1988) indicates that effective instruction for all students, and especially for minority students, must take place with the awareness that students construct their own, often quite unique, meanings of mathematics concepts. Such constructions are most likely to be useful for further learning (e.g., relational understanding; Skemp, 1978) when students have opportunities to experiment with models of concepts rather than merely trying to memorize content (e.g., instrumental understanding; Skemp, 1978). It is expected that the integration of computers will give students more opportunities to experiment with models than is typical of instruction centered around teacher monologues.

It is critical that teachers of minority students understand and model appropriate exploratory processes and appropriate constructivist techniques for learning mathematics so that students will become more involved with mathematics content. Workshops for such teachers must in turn model these techniques so that teachers will develop this understanding. Indeed, if teachers do not know how to use computers to solve problems, then they are likely to believe both that using computers is not important and that the students are unlikely to be able to learn mathematics in this way. Helping teachers learn mathematics in a constructivist way in a computer rich environment ought to help build teachers' confidence about using computer tools. As teachers gain confidence, they will be more likely to teach mathematics in ways that will enhance students' development of concepts.

Plan of Operation

The project's main objective is to improve K-12 teachers' knowledge of how to integrate computers into mathematics instruction, both globally across grades K-12 and locally to each teacher's particular grade-level responsibilities. This objective will be achieved in several ways:

1. Teachers will improve in their personal understanding of specific computer software for solving mathematics problems.
2. Teachers will acquire a global view of computer integration in the K-12 curriculum.
3. Teachers will identify ways to use computers in mathematics instruction, including the combined use of computers with cooperative groups or with other representational models.
4. Teachers will make informed decisions about which strategies to use in the context of their own classroom situations.
5. Teachers will implement the strategies that they select to use.

Overview of Sessions

Eight, full-day workshops have been scheduled for the project, five in 1991-92 and three in 1992-93. These workshops will be on days when students are dismissed from classes. About 50% of the total time will be for all teachers together, and about 50% will be for grade-level groups. In addition, teachers will keep journals about their use of computers and attempts that they make to use computers with students. Teachers will "debrief" their journals during inservice sessions, and they will be asked to send photocopies of their journals periodically to the project staff, so that the staff will have feedback on the development of understanding of integration of computers.

The whole group workshop sessions will address common instructional techniques (e.g., cooperative groups) as well as problems inherent in adapting instruction to fit multiple levels of understanding among students in the same class. Since the teachers represent grades K-12, they have quite different mathematics backgrounds. Consequently, these sessions are ideal for modeling how a teacher (i.e., workshop leader) can pose meaningful mathematical tasks that can be addressed at many different levels of sophistication by students (i.e., participant teachers) at many different levels of understanding. Such an approach is consistent with the vision of mathematics instruction set forth in the Curriculum Standards and the *Professional Standards*. For example, with the use of spreadsheet software, participants can examine several dozen (or even several hundred) elements in a series (e.g., 1/2, 2/3, 3/4, 4/5, 5/6, 6/7, etc.). At an elementary level, teachers might be asked to identify patterns in that series. At a more advanced level, teachers might be asked to predict the properties of element number 256,883 in the series. At an even higher level, teachers might be asked to write a convincing argument that the series approaches 1 without ever actually "reaching" 1.

The content of the grade-level-specific workshop sessions are geared to needs that the teachers identify. For example, graphics software might be introduced to the group as a whole, but particular software designed to meet grade-specific objectives (e.g., the graphing tool in IBM's *Time/Measurement/Money* for primary grades or *Geometric Supposers* for high school) would be reserved for grade-level-specific sessions.

1991 Fall Semester

In September, an overview of selected computer software was presented one day after school so that all teachers of mathematics in the three schools had an opportunity to understand the scope of the project. Then 12 participants were selected from the three schools. Two workshops were scheduled for Fall 1991. The workshops began with an overview of the Curriculum Standards. This information was communicated through a cooperative group activity, so that the teachers immediately experienced an instructional technique that they can use with their own students. At the first session, participants completed a survey of understanding about how to use specific software both to learn mathematics personally and to teach mathematics to students.

Early in November, a "Hardware Needs Assessment" was completed by the teachers in each of the three schools. This instrument was designed to help identify the hardware currently available for instructional use by the participant teachers as well as the physical resources (e.g., electrical outlets, appropriate furniture) available to support potential expansion. On the basis of this survey, participants, with advice from the project staff, will generate recommendations for additional acquisitions of hardware that would be needed to support fully the instructional techniques to be modeled in the inservice sessions. These recommendations will be forwarded in early 1992 to the building and district administration.

1992 Spring Semester

At the start of the semester, the teachers will again complete the survey of understanding of how to use specific software both to learn mathematics personally and to teach mathematics to students. They will participate in three more days of inservice; at the first of these days, attention will be given to the Professional Standards. Participants will begin to keep journals, and classroom visits by the project staff and by teachers to each others' classes will begin. The main purpose of the visits is to support the teachers as they begin to experiment with use of computers in their own lessons.

1992 June

A two-week inservice course will be held, during which the teachers will continue to develop their understanding of the use of computer software to solve problems and to teach mathematics to students. Scheduling this course soon after the end of the school year will encourage teachers to reflect deeply on their experiences with instructional software, before the perceptions of those experiences have faded. Some documentation of these experiences is provided in the participants' journals. The intense engagement of teachers with software over this two-week period (without the distractions of having to teach students), and the opportunity to build on their personal experiences as they have attempted to teach with computers during the preceding year, should allow the teachers to dramatically increase their understanding of appropriate uses of computers. At the end of the course, teachers will again complete the surveys of understanding. In addition they will formalize the classroom techniques they have been using by writing student activities for use in Fall 1992.

Roughly half of each day will be devoted to the development of written activities for students. The general process to be used will be that a grade-level group of teachers will discuss the techniques they used to try to teach a particular concept with computer software during the preceding year. The techniques that seemed to be most effective will be identified, and ways for committing this technique to a written form will be discussed. Then in pairs or triples, the teachers will write and edit the activity, with other teachers (perhaps from a different grade level) providing reactions to the written version. The project staff will also provide feedback.

1992 Fall Semester

The teachers will again complete the survey of how to use specific software. Comparison of the results of these surveys to the results of earlier administrations of the surveys will document the growth of teachers' personal understanding of appropriate uses of computers. During the semester they will use, and then revise, the student activities. They will also write brief reports of their classroom experiences (in the mode of continuing journal entries). Three additional inservice sessions will be held. There will be classroom observations by project staff to assist teachers in the implementation of the activities written during the summer and to assess the extent to which teachers are using instructional techniques discussed and modeled in the workshops.

	Data Source						
	Survey of Participants' Understanding	Workshop Evaluation Surveys	Course Evaluation Survey	Classroom Observations	Participants' Journals	Evaluation of Instructional Units	End-of-Project Survey
To what extent do participants understand how to use specific software to learn mathematics?	X			X	X	X	
To what extent do participants understand how to use specific software to teach mathematics?	X			X	X	X	
How successful are participants in planning mathematics instruction using computers?			X	X	X	X	
How successful are participants in implementing mathematics instruction using computers?				X	X		
How successful do participants think the program has been in helping them teach mathematics with computers?		X	X		X		X
In what ways have participants' perspectives on the roles of teacher and students in the classroom changed as a result of discussions on issues related to implementing computers in mathematics instruction?					X		X

Figure 1. Evaluation crosswalk.

Evaluation

Toward the end of each phase of the project, the project staff, one teacher representative of each building, and the Middle School Director for the district will confer about the success of that phase. Whenever they note weaknesses in a phase of the project, adjustments will be made in the next phase as an attempt to remediate those weaknesses. For example, if teacher survey information showed a lack of adequate growth in understanding of how to use software to solve mathematics problems, then more attention would be given to problem solving in future inservice sessions. If teacher observations showed a lack of implementation of strategies in classroom instruction, then more assistance would be given to teachers to help them implement strategies fully.

The formal evaluation plan has several parts: periodic surveys of teachers' understanding of how to use specific software both to learn mathematics personally and to teach mathematics to students, anonymous evaluations of each inservice session, course evaluation of the summer workshop, visits to classrooms to observe the extent to which instructional strategies are attempted and actually implemented, evaluation of the instructional units written during the summer workshop, and an end-of-project survey. In addition, the journals kept by teachers will be reviewed periodically to determine how teachers' perceptions change about the content and pedagogy of computers. The evaluation plan is detailed in Figure 1.

Results

To date the first two inservice sessions, the Software Usage Survey, and the Hardware and Facilities Survey have been completed. Some of the evaluations of the inservice sessions are presented in Table 1. Not unexpectedly, the responses show a pattern of increased comfort and expertise, with decreasing concern about immediate relevancy of software. On the free-response items, the two most frequent comments about both the first and second workshops were that the teachers enjoyed working with the software and that they enjoyed talking to other teachers.

Table 1. Evaluation of first two workshops.

Question **(abbreviated form)**	Workshop 1 *M*	 *SD*	Workshop 2 *M*	 *SSD*
Am more competent	3.25	0.72	4.13	0.83
See ways to use computers	4.00	0.82	4.63	0.52
Too much information	1.83	0.90	1.88	0.64
Need programs for immediate use	4.33	0.85	3.13	1.36
Lack of computer access	3.92	1.32	4.38	1.19
Handouts worthwhile	4.25	0.72	4.38	0.74
Activities were relevant	3.92	0.76	4.13	0.35
Workshop met expectations	4.00	0.82	4.43	0.53
More hands-on time	2.58	1.04	2.50	0.76
Better understand Standards	4.08	0.64	4.00	0.53

On the Software Usage Survey, 9 of the 12 teachers indicated that they had previously used computers for instruction. Only 2 of these 9 teachers indicated that they had provided handouts to accompany use of the software; in both cases, the software was not mathematics software. None of these 9 teachers had used any manipulatives along with the software. Two of the 9 teachers reported that they assessed effectiveness "by observation;" other teachers seemed not to have addressed the need to develop assessment procedures. The nine teachers listed 26 software packages that they had used, of which 11 were classified as drill and practice, 6 as tutorial, and 4 each as problem solving and gaming. Of the concepts taught by the software packages, number concepts were listed 19 times, algebra 4 times, and geometry 2 times.

The Hardware and Facilities Survey indicates that the schools are generally not well equipped. In the high school, there is one networked lab in the mathematics department, but it is used only rarely by teachers other than the one assigned to that room. In the middle school, computers are distributed among many different rooms, and it is unusual for more than two machines to be in any single place at a given time. In the elementary school, there is a Writing to Read lab, with almost no other machines available to use. In all three buildings, classrooms are inadequately equipped with electrical outlets, with lights that can be dimmed, and with blinds or window shades. Considerable, though not terribly costly, physical improvements need to be made in order to accommodate appropriate and convenient uses of computers in instruction.

Conclusions

Although the project is too new to permit significant conclusions to be drawn, there are several tentative patterns that appear to be developing. First, the beginning assumption of the project teachers about computer use appears to have been that computers will not change the substance of instruction, either in terms of content, pedagogy, or assessment. Computer integration projects must, therefore, provide a base of knowledge for teachers that will support a reanalysis of teaching along with a reconceptualization of the role of teachers. Second, teachers will only slowly engage in analysis of software to figure out how to use it to best advantage. Modeling of appropriate uses of handouts and manipulatives to support the instructional goals of software may be one effective way to promote such analysis, but this project is too new to provide any substantive data on this point. Third, the teachers seem somewhat surprised that they can learn important lessons from teachers at other grade levels. Creating a community of discourse across grade levels seems to be a very positive force in promoting coordinated change; but it can't be done quickly.

As the project develops, these conclusions are likely to need to be adjusted. Too, other patterns will certainly emerge. We look forward to learning much more about the process of integrating computers into mathematics instruction across the entire range of K-12 instruction.

Acknowledgements

Funding for this project was provided by the Eisenhower Higher Education Program of North Carolina (Contract No. 5-46393-E3-31) through the North Carolina Mathematics and Science Education Network (MSEN). All opinions expressed are those of the authors and do not necessarily reflect the positions of either the U.S. Department of Education or MSEN.

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Using Symbolic Calculators to Facilitate Constructivist Learning in Mathematics of Finance

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Abstract

The research investigated how constructivist learning activities affected students' attitudes and classroom dynamics in an applications mathematics course at the university level. In each of four semesters, one instructor taught a section of the course using business calculators and the constructivist approach to instruction. The instructor taught the students to use the symbolic calculators in class, on homework, and when taking tests. The instructor in the control sections allowed the students to use the calculators of their choice, typically four-function and scientific calculators. Students in the experimental sections spent less time in class doing lengthy computations and more time discussing the concepts of the course. Students in constructivist classes had significantly greater improvement in (a) general attitudes toward mathematics, (b) attitudes about the simplicity of mathematics, (c) enthusiasm for mathematics, and (d) locus of control over successes in mathematics. Both the students and instructors in constructivist classes asked more questions, in general, and more higher-level questions, in particular, during class than the students and instructors in traditional classes.

The availability of technology is changing the way people do many things today. In the past, for mathematics teachers to implement a variety of teaching methods has been difficult or impractical. Mathematics teachers spend much of class time teaching students how to do computations (National Council of Teachers of Mathematics, 1991). After demonstrating how to do computations using lecture-style teaching, little time is left for discussing applications, exploring the effects of making small changes in the parameters of problems, and focusing on the utility of mathematics as a tool for understanding real-life situations. Technology for doing arithmetic, as well as complicated higher-level mathematical computations, is now widely available. Calculators and computers can be used in mathematics classrooms as computational tools. To change the focus of mathematics classes from computation toward applications, contexts, relationships, problem solving, and decision making is then possible.

Class time made available by using technology for computing can be spent in a variety of ways. Instructors can use cooperative learning groups to increase student interactions, giving the students opportunities to verbalize and share their understanding of concepts (Slavin, 1983; Vygotsky, 1978). Students can learn by discussing differences in how they perceive concepts or how they would approach problems (Dees, 1991; Dolan, 1987; Johnson & Johnson, 1987). With the focus shifting from computing by individuals to working in groups to solve problems, students with different learning styles may be more successful than they have been in the past (Peterson & Fennema, 1985; Stiff & Harvey, 1988). Creative students who like to explore concepts or strategies may benefit from using technology to solve problems they generate themselves or to approach problems in unique ways. Students with field-dependent learning styles may benefit more from discussions and peer interactions than from working alone (Slavin, 1988, Stiff & Harvey, 1988). Using technology in mathematics classrooms provides time for engaging students in higher-level cognitive activities.

The intent of the research was to study how using symbolic calculators (HP-19B) to facilitate constructivist learning affects the quality and extent of student involvement in a university course, Mathematics of Finance. Students were given symbolic calculators and taught how to use them to solve the problems posed in the course. Class time that would have been spent doing computations by hand was spent on constructivist activities: working in groups, having students generate problems, having students present problems and solutions to the class, and discussing concepts and the interpretation of problems and solutions. The objectives of the investigation were (a) to compare students' attitudes, achievement, and problem-solving abilities in constructivist and traditional classes and (b) to monitor the nature of class participation in the constructivist classes and traditional classes and to describe the constructivist learning experience of teachers and students. The research also examined whether attitudes were different for males and females. The gender comparison was made overall and between the constructivist and traditional groups. Analyses of achievement and problem-solving ability will be discussed in a subsequent article.

Methodology

The subjects in this study consisted of members of eight sections of Mathematics of Finance at North Carolina State University between Fall 1989 and Spring 1991. Four sections were taught by Instructor A using constructivist learning methods and class sets of symbolic calculators; four sections were taught by Instructor B using traditional lecture teaching methods.

Documenting Constructivism

Observations. Although it cannot be directly verified that students were synthesizing what they were learning and constructing their own knowledge rather than memorizing algorithms, the frequency and type of questions asked in the classroom do reflect the quality of learning that students are experiencing. Teacher and student questions were tallied and categorized during weekly observations of both the traditional and constructivist classes. Because the traditional and constructivist classes followed the same syllabus, making observations of the same topics in both classes was possible.

Interviews. To further describe the constructivist learning experience, we interviewed many students to determine how the experience of participating in a constructivist mathematics class affected them. The results of the interviews provided anecdotal evidence of the effects of the constructivist approach. We also interviewed and observed Instructor A to determine how the experience affected her as a mathematics teacher.

Observations, student interviews, and teacher interviews were used to triangulate the results of constructivist activities in the classroom. We used these results to describe the affects constructivist activities have on teaching and learning mathematics.

Attitudes Instruments

Attitudes toward mathematics are comprised of how students feel about the subject in general, their anxiety or enthusiasm for the subject, their opinions about its usefulness, and whether they internalize their failures and successes (Aiken, 1970; Fennema & Sherman, 1978; Moore & Smith, 1987). Three tests were used to measure these different aspects that comprise attitudes toward mathematics: the Aiken Revised Math Attitude Scale, a semantic differential test measuring enthusiasm and opinions about the usefulness and simplicity of mathematics, and the Intellectual Achievement Responsibility Questionnaire (Crandall, Katkovsky, & Crandall, 1965) which measures locus of control.

Results

Classroom Dynamics

Teacher and student questions were tallied and classified as higher-level or lower-level questions. Higher-level questions referred to the meaning of problems, relationships, and expanding problems beyond their original realm.

In the constructivist classes, the instructor asked an average of 17.42 questions per class period, compared with an average of 9.00 questions per class period asked by the teacher in the traditional classes. The instructor in the constructivist classes asked nearly three times as many higher-level questions than the instructor in the traditional classes.

Students in the constructivist classes asked more questions overall and asked a higher percentage of higher-level questions. Students in the constructivist classes asked an average of 15.29 questions per class period, 47.66% of which were higher level, compared with an average of 10.57 questions asked per class period in the traditional classes, 33.79% of which were higher level.

Interviews and Observations

The processes involved in solving a Mathematics of Finance problem were: (a) read and analyze the problem, (b) identify the variables, (c) choose a formula for solving the problem (d) set up and solve the equations, and (e) interpret the results. Instructors A and B both emphasized the first three steps every time they worked a problem. Since step (d) was done using the symbolic calculators in the constructivist classes, this step took about 30 seconds, as compared with 15 to 30 minutes in the traditional classes. Students in constructivist classes reported during interviews that focusing on the first three steps made them easier. The immediacy of the results and the ability to rework problems, changing parameters for comparison, made analyzing results more meaningful. In the traditional classes, the time between reading and analyzing a problem and finding the result was so long that students often had to reread a problem to remember the question after solving it. No students in traditional classes ever asked a question in the first person, such as "what if I ..." and then changed parameters of the problem, although this occurred regularly in the constructivist classes.

Attitude Tests

Analyses of variance were done to compare the differences between pretest and posttest attitude scores for males and females in constructivist and traditional classes. Students in constructivist classes had greater improvement in general attitudes about mathematics, attitudes about the simplicity of mathematics, and enthusiasm for mathematics (all at $p < .05$). No differences in attitude changes about the practicality of mathematics existed between students in the traditional and constructivist classes. On these attitude measures, no differences existed between males and females overall or within either group.

Students in constructivist classes had a greater improvement in locus of control over successes in mathematics ($p < .0001$). No difference existed in change in locus of control over failures between the two groups. No differences existed in changes in locus of control between males and females; however, an interaction existed between gender and past success in mathematics relating to change in locus of control. High-school grade point average, SAT mathematics score, and university mathematics placement exam score were used to indicate students' past success in mathematics. For students in both constructivist and traditional classes, females with good mathematics skills had a greater gain in locus of control over successes than females with poor mathematics skills; the opposite was true for males.

Teacher Interview

The constructivist teacher reported that she had initially felt that if she did not teach students to solve equations, she would have nothing to teach. She was also concerned that if students were more active in the classroom they would interpret their new role as active learners as laziness on her part. The constructivist classes followed the same syllabus as the traditional classes, progressing through the topics at the same rate. Using technology allowed the class to concentrate on problem solving and conceptual understanding. They were able to work more realistic problems because they did not have to worry about cumbersome results or using tables. Instructor A reported that she had more time to allow students to ask "what if" questions and to let them generate and make decisions about problems. The students considered the experiences valuable. Her opinion about using technology to teach mathematics changed as a result of this experience.

Discussion

Using the symbolic calculators enabled the instructor to use class time engaging students in constructivist learning activities. The focus of the constructivist classes was on concepts and relationships and students were actively involved in learning. Students reported they were more confident in their work and enjoyed doing problems more because they were not focused on arithmetic and algebraic computations; they focused on ideas. They enjoyed working with other students and felt that the calculator enabled them to explore different ways to approach problems quickly and painlessly.

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Applications of the Graphics Calculator Related to Discrete Mathematics

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Abstract

This paper focuses on the utilization of the graphics calculator as a tool in enhancing various discrete mathematics concepts that may be covered within a secondary education mathematics curriculum. Areas in discrete mathematics where the graphics calculator has special utility include simulation of probability problems (Monte Carlo methods), graphically describing the concepts of exponential growth and decay, and generation of values obtained from discrete mathematical models that generate recurrence relations. The algorithm for simple function iteration is graphically demonstrated in a sample program. The various applications provided are appropriate for inclusion in a course in discrete mathematics for teachers and for an inservice workshop on graphics calculators.

One of the recommendations for change in the secondary school mathematics curriculum found in Curriculum and Evaluation Standards for School Mathematics (National Council of Teachers of Mathematics (NCTM), 1989, p. 176) is the integration of discrete mathematics topics within the existing mathematics curriculum. It is further recommended (NCTM, 1989, p. 8) that calculators be made readily available to all students. Lindquist, Harvey, and Hirsch (1989) agree that high school students must have access to graphics calculators. As a consequence of increased affordability, graphics calculators are becoming readily available to students in secondary schools. Yet few teachers and prospective teachers are aware of their potential for being used to enhance understanding of basic mathematical concepts.

According to the Kentucky Educational Reform *Act* (KERA, 1990), schools should make greater use of all forms of technology as tools for learning. As of fall, 1990, the Department of Mathematics at Morehead State University has a requirement that all calculus students purchase a graphics calculator, with the TI-81 currently being the preferred model. With the increased usage of these calculators in the classroom, it is anticipated that students in the mathematics education program will be well-positioned to apply calculators in a teaching environment. In light of the Reform Act recommendations, the Department is in the process of offering inservice workshops and graduate courses in the use of graphics calculator technology. This paper attempts to demonstrate applications of the TI-81 and Casio 7000 graphics calculators in order to better understand certain discrete mathematics concepts, namely, applications of discrete probability, discrete models resulting in recurrence relations, and implementing algorithms.

Discrete Probability

One area where the graphics calculator can be effectively used is in applying a Monte Carlo method to approximate a probability arising from an experiment. Consider the problem from geometry of estimating the value of the area of a unit circle, which is the number π. This problem is transformed into one of probability by noting that if a point is randomly chosen in a circumscribed square, it lies within the circle with probability π/4. The following TI-81 program graphically describes the process of randomly selecting 100 points in this square and using the information to estimate the value of π. Random numbers between zero and one are obtained with the *Rand* and *Ran#* commands on the TI-81 and the Casio 7000, respectively. Also, (1-2x, 1-2y) produces a random number in the displayed square when x and y are randomly generated between zero and one. The equation used for the upper semicircle is given by y = square root (1-x2).

```
TI-81 Program:       TI-81 Run:
ClrDraw              Enter circle equation in Y1:
DrawF  Y1            Y1 = (1 - X²) ^ .5
DrawF  -Y1           Set the range:
Line(-1,1,1,1)       Xmin = -1.5,  Xmax = 1.5
Line(1,1,1,-1)       Ymin = -1.5,  Ymax = 1.5
Line(1,-1,-1,-1)     Run the stored program
Line(-1,-1,-1,1)     A graph of the circle, square,
1 -> K               and 100 randomly generated
                     points will be displayed.
0 -> S               Four times the
Lbl 1                proportion of those points which
1 - 2Rand -> X       are within the circle results in
                     an approximation to π.
1 - 2Rand -> Y
PT-On(X,Y)
If X² + Y² < 1
1 + S -> S
IS>(K,100)
Goto 1
Pause
4S/100 -> P
Disp P
```

The instructions for the Casio 7000 program are similar to the above and will not be presented here. Another simulation that can be performed with these calculators is the Buffon needle problem: Randomly toss a needle of unit length on a striped floor and record the number of needle crossings on the stripes. Assuming that the distance between stripes is one unit, the probability of crossing is 2/π.

Exponential Growth/Decay

The graphics calculator can be used to illustrate the multiplier effect in describing the growth or decay of an exponential function. More specifically, if $y = C b^x$ is an exponential decay function ($C > 0$ and $0 < b < 1$), then students should be aware that as the value of x increases by one unit, y decreases by a factor of b. This can be restated by the following discrete process: the value of y at x + 1 equals the value of y at x, multiplied by b. Consider the following elementary exponential decay model which demonstrates the utility of the graphics calculator.

A 100 liter brine solution contains 5 kg. of salt (denoted by S0). Suppose that during the nth minute (n = 1, 2, ...), the solution is stirred and 10 liters are removed and replaced by 10 liters of tap water, resulting in an amount Sn of salt remaining in the container. Investigate the value of Sn over the first 20 minutes and determine that minute when the amount of salt drops below 1 kg.

Since 10% of the salt is removed each minute, the recurrence model is given by $Sn = .9S_{n-1}$ with initial condition $S_0 = 5$ kg. Students can set up an elementary program on the calculator to generate the values of the salt content after each minute and discover that after the 16th minute the salt content has dropped below 1 kg.

```
TI-81 Program:       Casio 7000 Program:
5 -> S               5 -> S
0 -> N               0 -> N
Lbl 1                Lbl 1
Disp N               N @
                      [@ symbol represents "HALT"]
Disp S               S @
Pause                .9S -> S
.9S -> S             1 + N -> N
IS>(N,20)            N < 21 => Goto 1
Goto 1
```

Since the decay factor is .9, the exponential decay equation for the salt content is $Sn = 5(.9)^n$. Students can graphically describe the salt content after each minute and determine when the content drops below 1 kg. This is accomplished on the TI-81 with range settings given by Xmin = 0, Xmax = 20, Ymin = 0, Ymax = 5 and by entering the functions Y1 = 5 * .9 ^ Int X and Y2 = 1. By using the trace command, one can determine when the Y1 graph drops below the Y2 graph. The same results can be obtained on the Casio 7000 by the same procedure.

Iteration Functions

Iteration of the form $x_n = f(x_{n-1})$ can be explored on the graphics calculator, where f(x) is a given function of x. As an example, consider the following program designed for the TI-81 graphics calculator. After entering the program, it is necessary to enter the function as Y1 = (expression in x), enter the y = x function as Y2 = X, establish the range settings, graph the function, move the cursor over to a location where iteration is to initiated, and then do a program run. By repeatedly pressing the ENTER key, new vertical and horizontal segments will appear between the graph of f(x) and the y = x line. Moreover, the sequence of iterates can be retrieved as the x-coordinate values in the statistics registers.

TI-81 Program:

```
ClrStat
Y1 -> X
1 -> K
Line({x}(K),X,X,X)
Lbl 1
K+1 -> K
Line(X,X,X,Y1)
Pause
X - >{x}(K)
Goto 1
```

Students can explore a wide variety of iteration functions and discover as to when convergence of the sequence of iterates x1, x_2, ... converges. This also quite naturally leads into a discussion of fixed-point behavior (i.e., where f(x) = x) and also to when chaotic behavior arises.

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Computer Graphics, Spreadsheets, and Expert Systems Workshop for Physics Teachers

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Abstract

During the summer of 1991, an intensive hands-on two-week workshop for high school physics teachers taught participants to use microcomputer-based graphics and spreadsheet software for classroom applications. As an exploratory topic, the characteristics and instructional uses of expert systems were the focus of the second week, with participants developing applications. Workshop objectives, methods and results are discussed.

The use of computer graphics and spreadsheets is dramatically impacting the teaching of undergraduate physics. The availability and ease-of-use of such technology has significantly broadened the spectrum and depth of possible instructional activities. At Ball State University, for example, laboratory and homework assignments in introductory as well as advanced physics courses require student application of this computer technology. The discipline-wide integration of this technology is evidenced by computer exercises in introductory physics textbooks (e.g., Serway, 1990) and the publication of books (e.g., Misner & Cooney, 1991) and manuals (e.g., Robinson, 1991) devoted to this topic. Most secondary school physics teachers completed their formal training prior to this relatively recent development. Thus a retraining need exists for many such physics teachers.

Expert systems, non-procedural computer programs that seek to mimic the problem-solving abilities of human experts, have a variety of educational applications, including intelligent tutoring systems (Anderson, Boyle, Franklin, & Reiser, 1985) and decision-making aids (Haynes, Pilato, & Malouf, 1987). The representations of knowledge and inference techniques in such systems have even aided the understanding of cognitive processes used by novice and expert physics problem-solvers (Hestenes, 1987; Trollip & Lippert, 1987). While many physics teachers regularly develop and use procedural computer programs, expert systems comprise a relatively unknown technology.

During the summer of 1991, an intensive hands-on, two-week workshop for high school physics teachers explored the instructional uses of selected microcomputer-based graphics, spreadsheet, and expert system software. Following afternoon classes in this three-credit-hour course at the graduate level, participants spent evenings and mornings working on assignments and projects. No prior experience with microcomputers was required. The general goal of the workshop was to have participants knowledgeable and proficient enough in the three types of software that they could and would use this technology in their own instruction.

Objectives

The graphical display and analysis of data plays an important role in physics instruction at all levels, but especially at the introductory level. Unlike the traditional hand-graphing techniques, extensive trial data manipulations and analyses may be rapidly accomplished using graphics software. The availability of color plotters and printers allows production of visually pleasing graphs for instructional applications.

While the technology is not new, many secondary teachers make no or only limited instructional use of it. One objective of the workshop was to provide teachers with hands-on experience and training with example microcomputer plotting software and hardware and to demonstrate specific physics instructional applications.

Conceptual and analytical modeling of physical phenomena is the core process in physics. The computer spreadsheet may be used to quickly implement analytical models and explore the consequences of those models through "what-if" questions. Teaching high school teachers about spreadsheets and how to develop applications for classroom instruction was the second objective of the workshop.

Expert systems were the speculative focus of the second week of the workshop. Objectives were to introduce teachers to this relatively new and exciting computer technology, to provide hands-on experience with a simple commercial expert system shell, and to develop instructional applications.

Methods and Facilities

A lecture-lab-homework format used in the workshop was supplemented by a great deal of individual attention provided by the two course instructors. The instruction for each software category began with a lecture concerning the general software characteristics and capabilities. This was followed by a directed, hands-on familiarization lab using the software. Handout materials (or in the case of the expert system, a user's manual) described the software operations including menus and keystrokes. The procedures to be followed in the familiarization exercises were specified in detail. For the expert system, participants completed tutorial materials in the user's manual.

A second lecture followed, addressing software operation and instructional applications. It utilized large-screen demonstrations of the software in action. Common assignments and custom projects with potential application in the teachers' classrooms were completed for evaluation in this course. Subsequent scheduled laboratory sessions and "free" evenings and mornings were necessary for participants to complete their exercises. Finally, the teachers demonstrated their completed spreadsheet and expert system projects for the entire group. For all exercises and projects, the emphasis was on applications appropriate for the instructional activities of secondary physics teachers.

During the workshop lectures, the Ball State University Video Information System (VIS) was utilized in the broadcast and local modes for displaying lecture materials. The primary medium used was still videos stored on diskettes and played in the classroom as well as from the central VIS facility under the instructors' control. The integrated use of such non-computer video technology in the workshop lectures sparked teacher interests in areas ancillary to the workshop goal. Participants were also given printed copies of the lecture notes and numerous handouts that provided supplementary information about the computer technology.

The workshop laboratory sessions were conducted in a microcomputer laboratory with one IBM Model 50z microcomputer available for use by each participant. Hard copy output was produced using various printers and several Hewlett Packard 7475A plotters. Specific software packages used by teachers were Grapher™ by Golden Software, Inc., Quattro Pro 3.0™ by Borland, Inc., and VP-Expert™ by Paperback Software, Inc. Participants were required to purchase the VP-Expert™ software and user's manual and a blank diskette.

Results

During this intensive workshop, secondary teachers acquired a variety of knowledge and practical skills in the use of graphics, spreadsheets and expert systems. Products submitted for evaluation and demonstration provided direct evidence of participants' progress in these three areas.

Graphics

After two intensive workshop days using plotting software, participants had generally acquired sufficient software and hardware skills to produce colorful XY plots for data display and analysis. Data input by keyboard and by importation of data files were the initial steps. Selection and control of the format and appearance of essentially all elements of a plot were practiced by each teacher. Sizing, positioning, scaling, annotating, coloring, titling of coordinate axes and selection of a grid quickly became simple tasks. Participants learned to plot multiple data sets on a single graph, to select, size and color data plot symbols, create legends and to place text at any desired position and orientation on the plot.

Analyses of data were performed using best fit methods for determining trends in data. Exercises and projects emphasized elementary applications that used curve fits that are the most likely to be used by physics teachers: the common linear regression, logarithmic, exponential and power curves. For example, a common laboratory experiment in introductory physics requires students to determine the acceleration of gravity by measuring the period of vibration of a pendulum as a

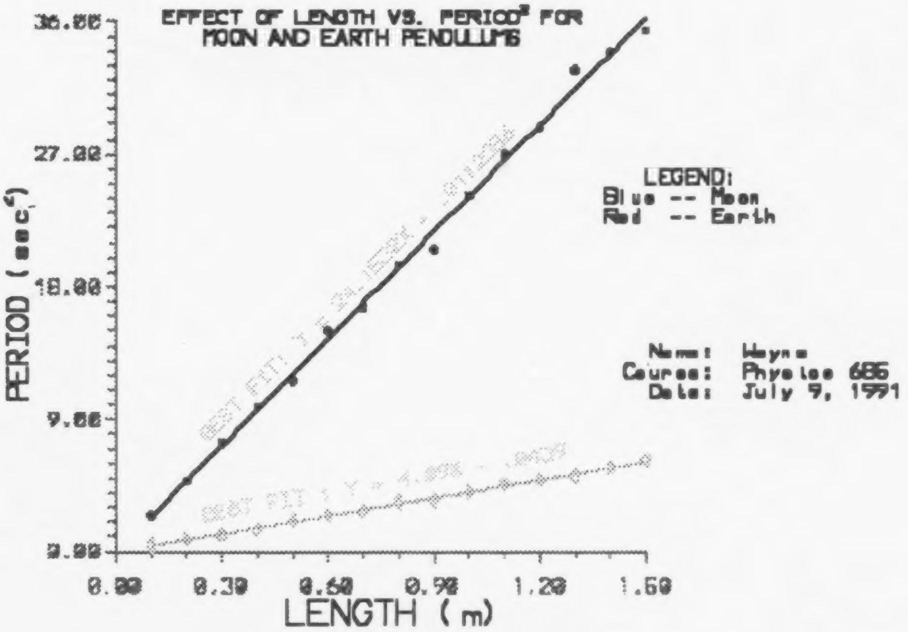
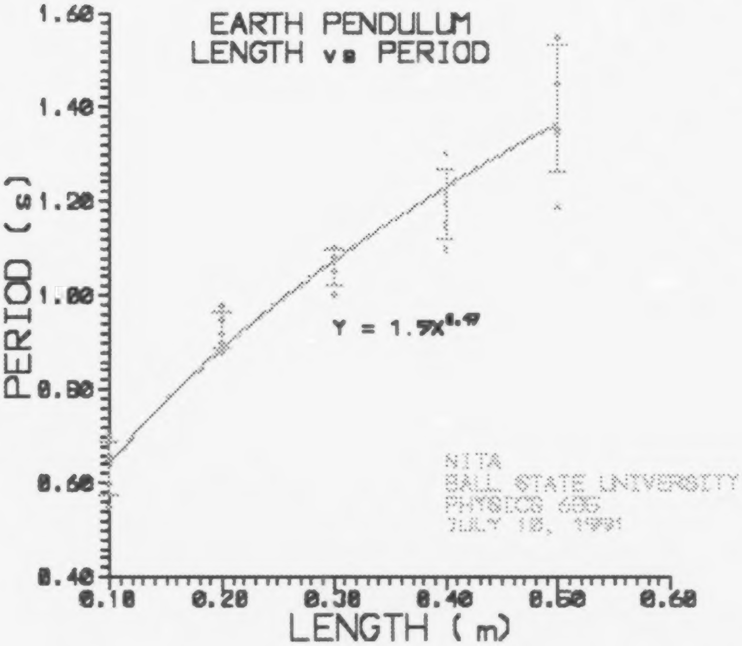


Figure 1. Moon and Earth pendulums.



** Figure 2. Earth pendulum.

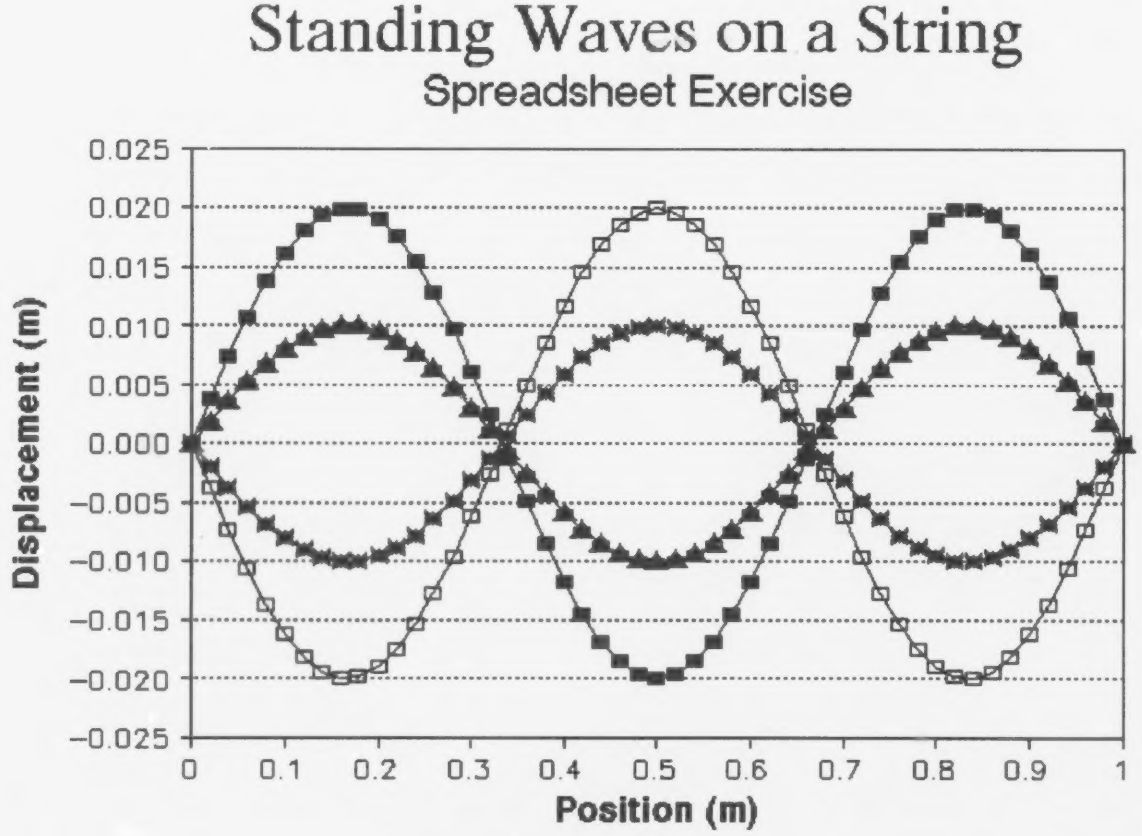
function of the pendulum's length. Completion of a pendulum data exercise by one participant resulted in plots for pendulums on the earth and the moon on a single graph as shown in Figure 1. The linear regression curve fits yielded slope values from which the accelerations were easily computed.

One important aspect of data analysis is the determination and display of data uncertainty. Participants learned to use the plotting software options for calculating data errors and displaying them as error bars on the data plots. Figure 2 depicts a physics teacher's plot containing the error bars with a power law curve fit.

Spreadsheets

With the hands-on emphasis in the spreadsheet segment of the workshop, participants rapidly acquired a working knowledge of this type of software. Most of the basic spreadsheet capabilities were explored. Participants learned about spreadsheet mechanics and structure. They learned how to enter data, address cells, create formulae and use built-in functions. The menu-driven nature of the software led to easy use of the editing functions, style changes and use of database functions such as sorting. Locking titles, using window panes, and manipulating files in multiple windows proved easy and useful to participants. The spreadsheet graphics capabilities were effectively utilized for a variety of applications.

Participants learned how to apply spreadsheets for modeling and simulation, simple analyses, electronic record-keeping, and the analysis and display of numerical data. In the initial familiarization exercise, the use of a spreadsheet for recording, sorting, analyzing and graphing student grades was a first for some of the teachers. An example spreadsheet file that performed elementary vector operations introduced workshop teachers to simple problem-solving using this technology and permitted observation and exploration of formula implementations. To initiate the use of spreadsheets for modeling and simulation, participants altered a spreadsheet model of the motions of freely falling bodies to a model of projectile motion.



An impressive result of the workshop was the completion of a variety of spreadsheet projects potentially useful in the teachers' science classes. Although descriptions of suggested projects were distributed, several teachers chose to develop spreadsheets based on their own instructional needs. One teacher chose to develop an extensive grades analysis spreadsheet. Another participant constructed a versatile model of a standing wave on a string. A sample graph for the latter application is shown in Figure 3. To view a different harmonic, the user only changes one input value followed by a single graphing keystroke.

In one optics application, the diffraction pattern for monochromatic light passing through a single slit was modeled. In Figure 4, the intensity pattern is depicted for two wavelengths. A user can merely change the input data to rapidly observe the effects of varying the incident light wavelength, the slit dimensions, or the distance to the observing screen.

Other physics applications dealt with the optics of mirrors, Newton's second law applied to inclined plane motion, Newton's universal law of gravitation, as well as satellite orbits. In all cases, participants were required to construct the spreadsheet with a title and sufficient explanatory text so that any user could understand the model and its applicability. For ease in making changes, the input data was always clearly identified and placed in contiguous cells near the top of the spreadsheet. Promoting clarity and ease of use, the organization of the spreadsheet was designed to encourage maximum use through "what-if" questions by users (potentially students in high school physics classes).

Expert systems

From the most speculative part of the workshop, expert systems, came the most satisfying and perhaps surprising results. By the end of the workshop, participants with no initial knowledge about expert systems had

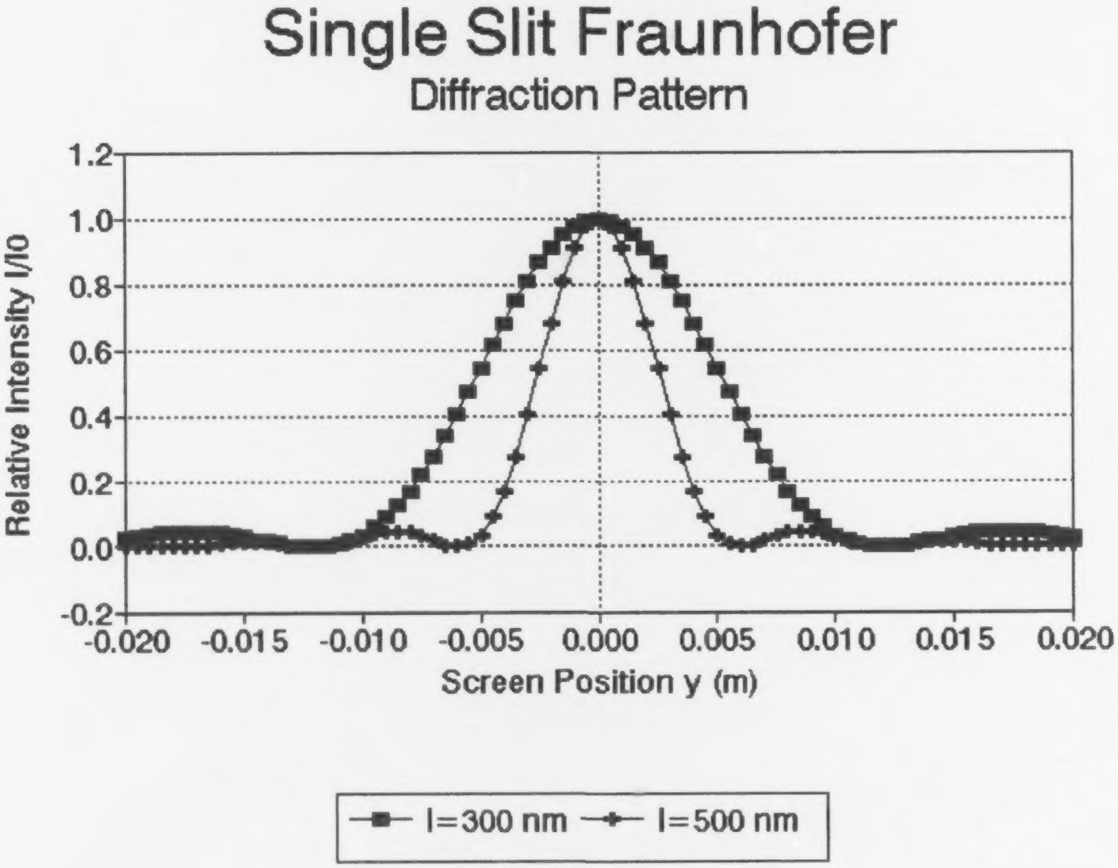


Figure 4. Single slit Fraunhofer.

constructed simple prototype systems that demonstrated the power and versatility of this technology.

Following the introductory lectures and tutorial exercises, each participant selected a problem domain for development of one type of expert system. Classification and advisor expert systems were the most popular. Using the VP-Expert shell, participants proceeded to formulate sets of "if-then" rules for the knowledge bases representing the chosen narrow problem domains. Development of the knowledge bases also required participants to include the goals of the "consultations," user inquiries for obtaining missing problem data, and information for justifying decisions or advice.

Expert system applications included classification systems for substances (elements, compounds, mixtures) and for elementary particles. One expert system advised the user on the best form of the ideal gas law to use when solving pressure-volume-temperature problems. Another participant attempted an expert system for solving projectile kinematical equations for a variety of initial conditions and unknowns. The complexity of this task prevented a timely completion but the attempt proved to be highly instructive for both participant and instructors.

Two expert systems were designed to assist grading through the inclusion of heuristic or "rules-of-thumb" information. One of the expert grading assistants used the participant's spreadsheet files as input data and provided advice in cases where students' grades were near a borderline. Another teacher's expert system helped in grading laboratory reports by applying subjective rules on report structure, organization, neatness, completeness and fulfillment of objectives.

Conclusions

The projects completed during the workshop indicated successful achievement of workshop objectives. This conclusion was reinforced by the teachers' positive evaluations of the experience. The few negative comments about the workshop related to hardware difficulties, software "quirks" and the time that the microcomputer laboratory was open. A follow-up questionnaire during the current academic year will assess how the workshop has impacted each participant's teaching.

Acknowledgements

The authors express their appreciation to Dr. David Ober for his administrative assistance during the planning and execution of this workshop.

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Graphical Display of Quantitative Data Using a Microcomputer

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Abstract

Schools today generate large volumes of quantitative data, and how these data are presented to the public determines how effective they are. This paper discusses three principles for presenting quantitative data in a graphical format. Included is discussion of various type of graphs with there advantages and disadvantages.

Schools today generate large volumes of quantitative data, and how these data are presented to the public determines how effective they are in influencing public opinion. Some special skills are required to transform quantitative data into a format, and at a level of sophistication, accessible to the public. That is, transforming data into useful information is both an art and a science—and is something the effective educator needs to learn. Unfortunately, these skills are rarely taught in teacher education programs.

Graphs (or charts) can represent an extremely useful and flexible medium for explaining, interpreting, and analyzing quantitative information. They display quantitative information visually by means of the combined use of points, lines, numbers, symbols, words, shading, and color. Graphs can do much more than simply substitute for numeric information; at their best, graphics are instruments for reasoning about quantitative information. Often the most effective way to describe, explore, and summarize a set of numbers is to look at pictures of those numbers. Of all methods for analyzing and communicating numeric information, well designed graphs are usually the simplest and at the same time the most powerful.

With the proliferation of computer graphing packages, "paint" programs, and the availability of numerous "clip art" packages, administrators now have the power to transform numeric data into a more meaningful and persuasive mode. But the fact that creating *attractive* graphs is now a relatively easy task does not imply that creating *effective* graphs is easy. "No amount of sophistication in computer technology alone is a substitute for genuine understanding and expertise in the theory and practice of graphic presentation" (Schmid & Schmid, 1979, p. 12).

Principles of Graphic Design

Quantitative data may be presented in bar charts, column and line charts, pie charts, and pictorial charts. Each graph has its advantages and disadvantages, which will be discussed below. First, let's look at three principles that can contribute to more effective graphs.

Match format to the intended audience. Meredith (1989) has suggested that one use the least sophisticated tool to make a case, thereby focusing on results and trends rather than fancy software procedures. An audience will not value the information if they cannot understand the graphic.

Keep it simple. Graphs and charts must be kept as simple as possible to avoid confusing the intended audience. "Graphs should never compare more than three elements with each other, and then only if the elements are reasonably clear and far apart" (White, 1982, p. 127).

Accuracy. The physical aspects of the graphic should reflect the greatest level of accuracy possible with the program being used. A graph should not be deceptive, distorted or misleading, or in any way susceptible to the wrong interpretation.

Type of Graphs

Graphics for presentation have one of the following purposes (Clagett, 1989): to show component proportions, item magnitudes, trends or time series, frequency distributions of items over ranges, or relationships. The standard graphs include bar, column, line, pie, and pictorial, and the choice of each is dependent on the kind of comparison being shown. While the purpose should determine the type of graph used, research and experience suggests some types are more effective than others.

Bar charts. Bar charts deserve greater usage due to their versatility and effectiveness, especially for showing item comparisons (MacDonald-Ross, 1977, p. 401).

Line and column charts. Excellent for showing time series and frequency distributions, line charts are used if the data being shown are continuous. Otherwise, a column chart should be used.

Pie charts. Most people get confused when many segments are used. Pie charts with more than three or four segments are a problem. The human eye has a hard time discriminating between small angles. "A table is nearly always better than a dumb pie chart; the only worse design than a pie chart is several of them, for then the viewer is asked to compare quantities located in spatial disarray both within and between pies" (Tufte, 1983, p. 178).

Segmented bar charts. Segmented or stacked bar charts lose the common reference line and make comparisons difficult among all but the bottom segment and should be avoided.

Three-dimensional graphs. MacDonald-Ross (1977), in a review, concluded that "segmented graphs and three-dimensional forms should never be used" (p. 401). When a graph has more dimensions than the number of variables it tends to lead to confusion.

Picture graphs. Picture graphs use pictures or symbols that are associated with the subject matter to show quantity. Picture graphs are less abstract and more understandable to the general public. When picture graphs are used the author must be careful that the representation of numbers, as physically measured on the surface of the graphic itself, is directly proportional to the numeric quantities represented.

In addition to the advantages and disadvantages of the individual graph, the mix of graphs needs to be considered. Page after page of the same type of graph should be avoided; the monotony can destroy an effective presentation. Zelazny (1985, p. 26) recommends a mix of 50 percent column and line graphs, 25 percent horizontal bar chars, 10 percent dot or scatterplots, 5 percent pie charts, with the remainder combination graphs. This mix varies from common practice, where pie charts are the most common and horizontal bar graphs are underused.

Graphical Integrity

"Incompetence and institutional deception produce graphics that lie," (Tufte, 1983, p. 77), so Tufte developed six principles of graphical integrity to ensure that graphics tell the truth about the data:

1. The representation of numbers, as physically measured on the surface of the graphic itself, should be directly proportional to the numeric quantities represented (The Lie Factor).
2. Clear, detailed, and thorough labeling should be used to defeat graphical distortion and ambiguity. Write out explanations of the data on the graphic itself. Label important events in the data.
3. Show data variation, not design variation.
4. In time series displays of money, deflated and standardized units of monetary measurement are nearly always better than nominal units.
5. The number of information-carrying dimensions depicted should not exceed the number of dimensions in the data (Confusion Coefficient).
6. Graphics must not be quoted data out of context.

Tufte's book should be read by anyone interested in the graphical display of data. In addition to not distorting the data, graphical excellence for Tufte consists of communicating complex ideas with clarity, precision, and efficiency, summed up in his principle (p. 51): Graphical excellence is that which gives to the viewer the greatest number of ideas in the shortest time with the least ink in the smallest space.

Conclusion

How administrators and teachers use graphics to present quantitative data to the public largely determines how effective they are in influencing public opinion. Simply because computer software has made creating attractive graphs an easy task does not imply that creating effective graphs is easy. "The usefulness of the product reflects on the value of the producer" (Clagett, 1989, p. 11). Educators should carefully evaluate how well they perform the data-to-graphic transformation.

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Cooperative Learning and Science Databases

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The information age finds scientific knowledge doubling every two years. Massive amounts of information are being put into science databases. Scientists rely on computers to manipulate the large amounts of data contained in these databases so that various configurations of the data can be generated. In this way, scientists, often working cooperatively, can spend more and more of their time on higher level thinking processes such as analyzing, synthesizing, and evaluating.

One of the challenges for science teachers is to help students learn to use those databases and assist each other in learning to work together to analyze information. Cooperative learning (Lyman & Foyle, 1990) can be combined with instruction on database searching to build a working environment in which students can sort through large amounts of seemingly unrelated data. The use of cooperative learning helps to facilitate higher level thinking skills such as the ability to order, interpret, and critically assess information (Johnson & Johnson, 1989; Slavin, 1990). The use of database searching helps students identify new patterns of information, clarify concepts involving rules of inclusions and exclusion, compare and contrast information, identify relationships involving correlations, make inferences from the data, test hypotheses, and draw conclusions (Watson, 1989). Each of these skills is vital in order to access, manipulate, and use the mass of data available today.

The particular strategy for combining cooperative learning with the use of a particular database is called *Think-Pair-Share* (Lyman, 1981, 1987; Lyman & Foyle, 1990). The sample database used in this paper is a small database on animals. First, each student 'thinks' about a question to be answered using the database. For example, what patterns would appear if the database were sorted alphabetically by animal names? The students then 'pair' and discuss their questions. By 'sharing' their questions and deciding on which question to focus on, the students are using higher level thought processes.

Figure 1 contains information regarding type of animal, surface, lungs, gills, wings and means of birth (Watson, 1989). The category "Animal" has been sorted alphabetically.

Using output of this sort, students are asked to examine the data and determine what characteristics can be used to classify animals into various types. From these observations they begin to make logical deductions. It should be clear that this particular output contains few recognizable patterns. (Obviously, as the database becomes larger, the task of identifying usable patterns becomes increasingly difficult, even when the data have been sorted "appropriately.")

Students should observe that an alphabetical sorting of names does not create patterns of data that provide useful information. The *Think-Pair-Share* approach can be

Figure 1. Animal database sorted alphabetically by "Animal."

Animal	Type	Surface	Gills	Lungs	Wings	Birth
Bat	Mammal	Hair	No	Yes	Yes	Live
Cat	Mammal	Hair	No	Yes	No	Live
Crocodile	Reptile	Scales	No	Yes	No	Eggs
Dog	Mammal	Hair	No	Yes	No	Live
Frog	Amphi.	Smooth Skin	Yes	Yes	No	Eggs
Halibut	Fish	Scales	Yes	No	No	Eggs
Lizard	Reptile	Scales	No	Yes	No	Eggs
Owl	Bird	Feathers	No	Yes	Yes	Eggs
Platypus	Mammal	Hair	No	Yes	No	Eggs
Robin	Bird	Feathers	No	Yes	Yes	Eggs
Salamander	Amphi.	Smooth Skin	Yes	Yes	No	Eggs

employed once more to overcome this difficulty. Working together, for example, students may ask if sorting on another characteristic, such as "Surface," would be better. Students pair together and share once again to decide whether this question would be worth pursuing. If they decide to do so, the database can be resorted.

Figure 2 displays the output of this second sort. Computers can do these sorts fairly rapidly, though of course the larger the database, the greater the time required.

By looking at this new sort, students may begin to note some of the characteristics that distinguish one animal group from another. Surface characteristics distinguish among mammals, birds, and amphibians but are less helpful in distinguishing between reptiles and fish. Students can see, for example, that at least one mammal flies and another lays eggs. These and other relationships illustrate how a more detailed and comprehensive classification scheme must be used to subdivide within categories. To obtain additional patterns, students might sort the database by other characteristics such as "Gills" or "Lungs."

Because of their power, computers provide considerable assistance to students in reordering information into revealing relationships. Even a small database stored on a small personal computer can provide an appropriate starting place for the use of scientific databases. Students can see from these simple examples not only that inferences can be drawn but also that this process might be applied to other classification schemes such as invertebrates, bacteria, and plants. This helps students develop the idea of classification, and the scientific method can be discussed in the context of these real student experiences. Students then are ready to use even large databases (for example, from NASA and Telenet) and to do more team exploration. In addition, the process of *Think-Pair-Share* provides the collegiality that scientists often enjoy in their communities.

Figure 2. Animal database sorted alphabetically by "Surface."

Animal	Type	Surface	Gills	Lungs	Wings	Birth
Owl	Bird	Feathers	No	Yes	Yes	Eggs
Robin	Bird	Feathers	No	Yes	Yes	Eggs
Cat	Mammal	Hair	No	Yes	No	Live
Dog	Mammal	Hair	No	Yes	No	Live
Platypus	Mammal	Hair	No	Yes	No	Eggs
Bat	Mammal	Hair	No	Yes	Yes	Live
Halibut	Fish	Scales	Yes	No	No	Eggs
Lizard	Reptile	Scales	No	Yes	No	Eggs
Crocodile	Reptile	Scales	No	Yes	No	Eggs
Frog	Amphi.	Smooth Skin	Yes	Yes	No	Eggs
Salamander	Amphi.	Smooth Skin	Yes	Yes	No	Eggs

• Educational research supports the using of databases in problem-solving activities (Steinberg, et al., 1986). White (1987) found strong evidence that computers assist the problem-solving efforts; in particular, students can identify whether available data is adequate to solve a problem, and can sort data into new patterns to provide new insight into a problem. Students can also collect their own data; develop their own databases; learn to disaggregate data, classify data, and use the scientific method; and develop social skills needed to work with others (Kendall & Budin,1987; Yates & Moursund, 1988).

Conclusions

Dealing with the tremendous growth of scientific data and information is one of the most important challenges facing scientists and teachers. By using the computer and scientific database, students can be taught to get a handle on that explosion. In addition, the use of cooperative learning strategies such as Think-Pair-Share can begin the process of team work that is so crucial in the scientific community. Using the computer to investigate various scientific databases while providing social skills should be a goal of every science educator.

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TELECOMMUNICATIONS

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A number of significant events took place in educational telecomputing during 1991. In April the National Science Foundation underwrote a foundational conference hosted by the Technical Education Research Centers (TERC) for establishment of a Consortium for School Networking (CoSN). Subsequent organizational meetings at the National Educational Computing Conference and the annual EDUCOM meeting led to adoption of a constitution for the organization. In a position statement to the U.S. Secretary of Education, endorsed by representatives of more than fifty educational organizations and state departments of education, the Consortium for School Networking called for extension of the Internet to public schools on a nationwide basis:

> Networking for K-12 will best be accomplished, we believe, by using as a backbone the existing national network infrastructure serving post-secondary education, scholarship, and research: the interim National Education and Research Network (NREN). (Consortium for School Networking, 1991)

In November the High Performance Communications Act was enacted. This act will establish a National Research and Education Network (NREN). Senator Albert Gore, sponsor of the act, suggests that the Internet, bolstered by the new NREN backbone, could revolutionize public school education:

> This network could revolutionize American education as well, giving teachers new tools and new ways to inspire their students. Today, hundreds of elementary and secondary schools are linked to the NSFNET, enabling students to exchange messages with other students throughout the country and enabling teachers to share new teaching ideas with one another (Gore, 1991, p. 16).

The Internet

The Internet is already a *de facto* standard at institutions of higher education. Many of the articles in this year's telecommunications section describe activities that are conducted through the Internet, or are accessible through an Internet connection.

Because of its significance, the position paper containing the *Recommendations of the Consortium for School Networking to the U.S. Secretary of Education* is reprinted in full as the first article in this section. This position paper has already had an effect in some areas. For example, the IBM National Education Advisory Board (NEAB), consisting of deans from representative schools and colleges of education working with IBM, subsequently issued a recommendation to IBM recommending that all future IBM K-12 educational products related to telecomputing and establishment of wide area networks be compatible with the existing Internet standard. The policy recommendation of the NEAB is also reprinted in full.

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Virginia and Texas were among the first states to establish statewide public school networks that guarantee every public school educator access to the Internet. "Models for a National Education Network," by Bull, Cothern, and Stout, compares similarities and differences in the methods employed in those two states to establish educational networks. The full range of educational resources available through the world-wide Internet system is so vast that it can be overwhelming for the novice user. Kearsley and Lynch received a National Science Foundation grant to develop information about educational resources on the Internet that might be of interest to teachers. Their article, "From Bulletin Boards to Internet," describes their approach to development of strategies that will encourage teachers to use the Internet.

It is important to begin incorporating instruction on use of the Internet into pre-service teacher education programs if teachers are to use this instructional tool effectively after graduation. In "Using Telecommunications in Teacher Education," Bishop-Clark and Huston describe how the Internet was used to demonstrate use of electronic mail, among other activities, in an experimental course at the University of Cincinnati. Sue Eskridge was one of the developers of Teacher-LINK, the prototype network at the University of Virginia that eventually led to development of Virginia's Public Education Network. She subsequently developed the Pacific-LINK network at the University of the Pacific. In "Pacific-LINK: Supporting New Teachers through Electronic Conferencing," Eskridge and Langer describe how this network supports new teachers by linking them with experienced teachers and university faculty. Faculty and students at California state universities (CSU) have access to the Internet through CSU-Net. In "Teacher-Net: Student Teachers form a Community of Teachers," Casey describes how a grant from the CSU system was used to enhance the student teaching process at California State University at Long Beach. In "Making Connections beyond the Classroom Walls," Schneiderman described how the New York state network, Technology Network Ties (TNT), was used to connect education students at Long Island University to the Internet through an undergraduate course appropriately titled "Connections." This course is designed to facilitate learning by establishing connections beyond the classroom walls.

At Nova University both telecomputing systems and audio teleconferences are used to deliver distance education courses. In "Distance Education: $\Sigma >$ the Whole," Mizell, Marcus, Hesser, and Hogan describe how these technologies have been employed in the teacher education program at Nova University. Harvey Kaye describes how a Technology Education program prepares educators to teach telecommunications at City College of the City University of New York. In "Teaching the Broader Spectrum of Telecommunications," Kaye explains how this program spans the range from the telegraph and Morse code to use of the Internet.

Numerous resources are available through the Internet, and as colleges and schools of education begin to increasingly avail themselves of this world-wide academic system numerous resources specifically related to teacher education will begin to emerge. In "National Education Technology Information Exchange," Nancy and Robert Wilson describe resources available through an education Information Exchange (NETIE) that can be accessed via the Internet. Often accessing resources of the Internet may require familiarity with capabilities such as "Telnet" and "File Transfer Protocol (FTP)." In the final paper in this segment, "Telecommunications for Teacher Education: Beyond E-Mail," Dee Anna Willis and Elissa Keeler provide readers with a basic introduction to locating and connecting with the many interest groups that operate on BITNET and the Internet.

Bulletin Boards and Information Services

Colleges and schools of education serve as technologic laboratories for evaluation of different ideas and approaches. The articles in the second segment of the Telecommunications section describe telecomputing projects developed through private bulletin boards and commercial telecommunications services. In the future many of these systems may also be gatewayed to the Internet. For example, after a trial experimental period, a permanent gateway between AppleLink and the Internet was established on a permanent basis in 1991. Other commercial services may follow in the future.

In "Information Age Innovations: Online Teacher Enhancement," Lynne Schrum describes use of the GTE Network in a course on telecommunications at the University of Oregon sponsored by the International Society for Technology in Education (ISTE). Students participated in this distance education education course from locations across the United States and Canada. At Purdue, Mark Whitman elected to use the Prodigy system, another commercial computer network, to facilitate communication among faculty and students in the Purdue School of Education and alumni of this program. "Purdue and Prodigy as Partners" describes the methods used to implement this approach.

Another approach uses a technology imported from France, the Minitel system. In "Graduate Students and Fourth Graders, Connected at Home on a Commercial Telecommunications Service," Erickson and Mountain describe how the videotex system of the Videotel network was employed in a teacher education project. In "PSI-Net as a Tool for Classroom Learning," O'Dell and Pedersen describe how this network developed by IBM was used to facilitate a course for in-service teachers developed at the

University of Arkansas. The SpaceMet bulletin board was used to aid full-time teachers who were also enrolled in the Mathematics, Science, and Instructional Technology doctoral program at the University of Massachusetts at Amherst. In "Electronic Networks for In-Service Teacher Education," Schultz and Konicek describe their efforts to reduce the incidence of teachers who fail to complete their doctoral dissertation after successfully completing their other doctoral work.

In the final paper in this segment, San Nicolas, Shuster, Caplan, and Foster describe establishment of networks and databases in the College of Education at the University of Guam. As their article, "Educational Connectivity," suggests, a system that encompasses more than 1300 students who are sometimes as much as five hours away by air travel presents some special educational challenges.

Video Connections

The majority of the papers in the Telecommunications section address use of telecomputing and computer networks. The term "Telecommunications" also encompasses a range of other technologies such as video teleconferences.

In the "Appalachian Distance Learning Project," Flemister describes a fiber optic system at Ohio University that not only offers telecomputing services but full-motion video technologies as well. Campbell, Bruning, and Nickerson describe use of two-way interactive television in the teacher education program at the University of Minnesota at Twin Cities in their article, "Multiple Site Inservice Teacher Education via Interactive Television."

For those who may be contemplating establishment of distance education classrooms employing video technologies, Persichittee provides some guidelines that should be considered in the process of designing such a system. Her article, "Considerations for the Design of Distance Education Classrooms," describes key considerations in five areas.

Theory and Research

The papers in the fourth segment of the Telecommunications section address theoretical considerations related to educational telecommunications. In "Organization of Successful Teacher Education Activities on Electronic Networks," Stapleton, Levin, and Waugh analyze some of the phases through which educational telecomputing projects may progress, and introduce the concept of "Teleapprenticeships." Waggoner outlines some of the factors that should be considered in "Planning for Use of Computer Conferences in Collaborative Learning."

Judith Harris served as field director of the Teacher-LINK program at the University of Virginia. She concluded that basic research is essential to the process of identifying factors affecting use of educational networks by novice users. In "Writing Apprehension, Computer Anxiety, and Telecomputing," Harris and Grandgenett explore several of the relationships associated with patterns of use.

The Jason project is a well-known educational initiative that permitted elementary and high school students to observe a series of undersea explorations through video signals transmitted via satellite downlinks. Bazler, Spokane, Ballard, and Fugate investigated the effects on attitudes toward science associated with participation in the Jason project. The results are described in their article, "The Jason Project Experience and Attitudes toward Science as an Enterprise and Career."

Summary

Almost every major university in the United States is linked to the Internet. Faculty and students in other disciplines such as engineering and business routine take advantage of the resources afforded by this world-wide academic network.

As the articles in the Telecommunications section of this year's *Technology and Teacher Educational Annual* demonstrate, faculty and students in teacher education programs are increasingly beginning to make use of the Internet. A number of events that occurred in 1991, from the formation of the Consortium for School Networking to passage of the High Performance Computing Act, increase the probability that there soon may be a national education network that links all schools from kindergarten through graduate school.

Reference

Gore, A. (1991) Viewpoint: A networked nation. *Communications of the Association for Computing Machinery, 34* , 15-16.

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Position Paper on School Networking

Consortium for School Networking

[Editor's note: On July 25, 1991, the Consortium for School Networking transmitted the following position paper on school networking to the U.S. Secretary of Education, Lamar Alexander.]

The Honorable Lamar Alexander
Office of the Secretary
U.S. Department of Education
400 Maryland Ave., S.W. Room 4181
Washington D.C. 20202

Dear Mr. Secretary:

In April of this year the National Science Foundation funded a conference to bring together leaders from many sectors of the nation, to address issues surrounding the use of electronic networks in the nation's primary and secondary schools. As a result of the meeting, a Steering Committee has been formed to establish a Consortium for School Networking. We write to offer our support as a resource as the nation, in support of the President's America 2000 education strategy, links K-12 education together through computer-mediated communications networks.

Networking for K-12 will best be accomplished, we believe, by using as a backbone the existing national network infrastructure serving postsecondary education, scholarship and research: the interim National Research and Education Network (NREN).

Linking together one or more schools from every congressional district offers an enormous start on local connectivity for all schools. Further, as the New American Schools develop and provide models for other schools to consider and work from, electronic networks can be an effective support for translating research into practice, can help create communities of learning across geographic boundaries, and can provide a basis for collaborative work between groups of teachers, administrators, and students. In short, the effort to network the 535 New American Schools can be highly leveraged with few additional resources to become a major program to extend both networking, and the benefits of the experience of the New American Schools, to all of K-12 education.

Enclosed with this letter is a set of guidelines for K-12 network development, prepared by the Consortium for School Networking. The document presents a rationale for the extension of computer-mediated communications broadly to K-12 education, and recommends four priority directions for policy: acceptance of the existing interim NREN as the backbone structure for K-12 networking; support for K-12 user training and orientation; provision of a national directory resource; and R&D in network applications for K-12 curriculum, instruction, and administration.

We believe that actions based on these recommendations can put in place the elements the New American Schools will require to communicate effectively among themselves and with all the nation's schools and, furthermore, can provide a wealth of new resources for the entire K-12 educational community.

The undersigned members of the Consortium for School Networking are a collectivity of educators, researchers and professionals from many sectors of the nation who are united in their concern for the success of K-12 restructuring and reform, and in their belief that computer-mediated electronic networks can make a significant contribution to the progress of such reforms. A fundamental goal of this Consortium is to increase the number of educators and educational leaders who understand, and are committed to the belief, that education in America can be advanced through the integration of electronic networks as a tool for K-12 education.

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Internet Recommendation

IBM National Education Advisory Board

In 1991 the National Science Foundation sponsored an organizational meeting at which the Consortium for School Networking (CoSN) was formed. In a position statement to the U.S. Secretary of Education endorsed by Beverly Hunter of the National Science Foundation, Sam Matsa of IBM, and representatives of more than forty educational organizations and state departments of education, the Consortium for School Networking called for extension of the Internet to public schools on a nationwide basis:

Networking for K-12 will best be accomplished, we believe, by using as a backbone the existing national network infrastructure serving post-secondary education, scholarship, and research: the interim National Education and Research Network (NREN). (Consortium for School Networking, 1991)

Senator Albert Gore, sponsor of the High Performance Computing and Communications act, notes that the Internet, bolstered by the proposed National Education and Research Network (NREN) backbone, could revolutionize public school education:

This network could revolutionize American education as well, giving teachers new tools and new ways to inspire their students. Today, hundreds of elementary and secondary schools are linked to the NSFNET, enabling students to exchange messages with other students throughout the country and enabling teachers to share new teaching ideas with one another (Gore, 1991, 16).

The Internet currently serves as the common academic network which links colleges and universities in the United States. As elementary and secondary schools are connected to wide area networks, it is important that they be linked to a common system compatible with the Internet, rather than to incompatible networks which separate public schools from universities and government agencies.

Therefore, in order to support establishment of a single seamless network linking educators from kindergarten through graduate school,

> ***Be it resolved that the position statement of the Consortium for School Networking, contained in its recommendations to the Secretary of Education, be used as the basis for development and implementation of technologies which connect public schools to wide area networks.***

References

Gore, A. (1991) Viewpoint: A networked nation. *Communications of the Association for Computing Machinery, 34* (11), 15-16.

Consortium for School Networking. (1991) *Internet recommendation: Position statement to the U.S. Secretary of Education.* (Available from John Clement, Educom K-12 Networking Project, 1112 Sixteenth Street N.W., Suite 600, Washington, D.C. 20036.)

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Models for a National Public School Computing Network

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Abstract

Passage of the High Speed Communications Act, resulting in establishment of the National Research and Education Network (NREN), increases the probablity of a national education network that encompasses both K-12 education and higher education. The Internet has already become a *de facto* networking standard for institutions of higher education. Virginia and Texas are among the first states to provide universal access to the Internet for all public school educators as well. Similarities and differences in approaches to establishment of statewide public school computer networks provide models for other states that may be contemplating development of similar statewide systems linked to the Internet.

The Internet is the primary networking tool that links academic institutions. The Internet is a collection of high-speed wide area computer networks that link educational institutions, commercial firms, and government agencies. More than 3,000 networks are connected through the Internet. (Quarterman, 1991)

The protocols associated with the Internet have served as the standard for computer networks connecting institutions of higher education, permitting them to communicate with one another. In contrast, a variety of diverse and incompatible networks and networking protocols have been adopted for various K-12 networking schemes. Recently, however, a consensus has been emerging for adoption of Internet protocols for K-12 systems as well as for institutions of higher education.

In Spring 1991 the National Science Foundation sponsored an organizational meeting at which the Consortium for School Networking (CoSN) was formed. In a position statement to the U.S. Secretary of Education, endorsed by representatives of more than fifty educational organizations and state departments of education, the Consortium for School Networking called for extension of the Internet to public schools on a nationwide basis:

> Networking for K-12 will best be accomplished, we believe, by using as a backbone the existing national network infrastructure serving post-secondary education, scholarship, and research: the interim National Education and Research Network (NREN). (Consortium for School Networking, 1991)

The reason for adoption of the Internet as a common standard for both K-12 and higher education is straightforward: it is already a *de facto* standard in post-secondary research and scholarly communities. Because of the common standard of the Internet, a faculty member at any university can transmit a message to a faculty member at any other university, post news on a common conferencing system, access files and databases at other institutions, and log onto remote computers at other locations.

In contrast, K-12 networks have heretofore consisted of a patchwork quilt of incompatible systems and standards. Extension of the existing Internet standard to K-12 education would make it possible to link all of education from kindergarten through graduate schools. Use of separate, incompatible networks for K-12 and higher education accentuates existing barriers that already separate the two levels of education. Adoption of a common standard will encourage cooperation and collaboration. It would also result in the establishment of a national public school computing network. In some cases this could be accomplished by developing gateways to the Internet for currently isolated K-12 networks. The Internet permits each network to be customized to meet the individual needs of each state or educational level, while providing a common set of protocols that permit the various networks to communicate with one another.

On December 9, 1991 the High-Performance Computing Act was signed into law. This act calls for development of a National Research and Education Network (NREN), and increases the likelihood that a national education network based on Internet protocols will be established. Senator Albert Gore, sponsor of the High-Performance Computing Act, suggests that the Internet, bolstered by the National Education and Research Network (NREN) backbone provided for by this act, could revolutionize public school education:

> *This network could revolutionize American education as well, giving teachers new tools and new ways to inspire their students. Today, hundreds of elementary and secondary schools are linked to the NSFNET, enabling students to exchange messages with other students throughout the country and enabling teachers to share new teaching ideas with one another. (Gore, 1991, p. 16)*

Several states have already developed public school educational computing networks based on Internet protocols. The California Department of Education and the California State University (CSU) network system have formed a partnership to extend Internet services to public school teachers in California. The New York state branch of the Internet, NYSERNET, has initiated a program to provide public school educators with access to Internet services in that state. Florida's Information Research Network (FIRN), Project REACH in South Carolina, and the Big Sky Telegraph in Montana are among other projects that provide public schools with access to the Internet in those states.

Virginia and Texas are perhaps the first states to assure comprehensive access to the Internet to every educator in the public schools. This right of information access is a common one for university faculty. As information is increasingly stored in electronic form, access to the academic network becomes as vital as a library card for conduct of scholarly work. Extending these rights of information access to the public schools raises a number of issues.

Some of the issues involved in comprehensive statewide public school access to the Internet are technologic while others involve public policy. In many instances Virginia and Texas have adopted similar approaches to common problems while in other cases different methodologies have been employed. A review of the initial experiences associated with statewide Internet access for the public schools may be useful for other public school systems considering similar steps.

The Virginia Department of Education was chartered to establish a statewide telecomputing network through its *Strategic Plan for 1988-94* that was approved after legislative review. (Virginia Board of Education, 1989) In Texas a legislative commitment was established through Senate Bill 650 of the Texas Legislature, *Technology and Telecommunications in Public Education.* (Parker, 1989)

Extensive consultation between the states took place during the planning phases for the two networks. Connie Stout, director of the Texas Education Network, made several trips to Virginia to consult with staff at the Virginia Department of Education and the University of Virginia, and additional communication also took place (as might be expected) via electronic mail. The intent was to not only establish statewide educational networks, but to prepare for eventual collaboration and instructional interaction among teachers in Virginia and teachers in Texas.

Common Standards

In a position statement developed through these meetings, agreement upon several principles for establishment of the networks was attained. These included the following general principles in the areas of architecture, interface, and equity. (Bull, Sigmon, and Stout, 1989)

Architecture

1. based on standard Internet protocols
2. use of a distributed computing system
3. open access for multiple operating systems

Interface

4. simple to use, with minimal training
5. standard across all school districts

Equity

6. equally accessible for all school districts

Standard Internet Protocols

Standard protocols employed within the Internet for K-12 education were adopted in anticipation of the possibility of a future national public education network. In both states there was also a desire to link K-12 education and higher education rather than to separate them by incompatible networks.

Distributed Computing

Adoption of a distributed computing architecture was motivated by economics rather than policy. In the past the classic model for computer bulletin boards has consisted of a central mainframe computer accessed via modem through either a long-distance phone call or a telecommunications service such as Telenet or Tymenet. The widely used commercial service, CompuServe, is an example of this computing architecture. The chief drawback of this method is cost. Connect time charges for telecommunications access are usually high. For that reason it is often necessary to limit instructional use, or limit access to those within the local phone district. In a number of instances, educational networks of this kind established through grant funding were dismantled when the funding was discontinued.

Therefore, in order to design a self-sustaining network providing levels of instructional access similar to those found in university environments it was necessary to reduce connect charges. A distributed computing network provides a means of accomplishing this. In a distributed computing system, the model of a single mainframe computer in a central location is replaced by computing power distributed across the network. During the 1980's this model was widely adopted in both universities and commercial settings.

In Virginia, Unix systems consisting of Intel 80386-based microcomputers were distributed at nodes across the network. This permitted users in areas with high population densities to access the network with a local phone call. (Educators in other areas would be able access the network through a toll-free call.) This strategy greatly reduced the cost of connect charges for network access. In Texas, a similar strategy was employed to permit users to access the network through a local phone call, but terminal servers were used in place of actual host computers at the various nodes. Although the technology employed was different, the end result was the same in both locations.

Open Access

The third principle agreed upon relative to network architecture was open access for all microcomputer operating systems (Apple II, Macintosh, MS-DOS, MS Windows, OS/2, etc.). The reasons for adoption of such a standard are obvious: to protect the economic investment of the schools in their existing machines, and to eliminate a bias toward any one vendor. Adoption of this standard had a less obvious implication: as a practical matter, this would imply the network would be accessible through commercially-available microcomputer telecommunications software.

Prior development efforts in Virginia had demonstrated that it is difficult to develop special-purpose microcomputer telecommunications software that is competitive with that produced by commercial vendors. Such special-purpose software is invariably better-implemented on some systems than others, and often it is not current with the latest versions of microcomputer operating systems released by vendors. Maintaining it becomes a full-time effort in itself. For that reason, a decision was made to focus on software development and implementation efforts at the host end rather than the microcomputer end.

Intuitive User Interface

Insistence upon a simple interface that can be easily learned with minimal training is a necessity in a public school environment. Teachers rarely have the time that university faculty can devote to memorization of counter-intuitive user interfaces. Therefore, as a practical matter, the user interface must be easily understood by first-time users. Although this principal is easy to specify, in practice it can only be achieved by observing pilot users and then modifying the elements of the interface that present difficulty. This implies an on-going research and development program in which the user interface is modified to meet users needs, as opposed to a methodology in which an ever-increasing body of training materials is developed to compensate for the deficiencies of the system.

Within a given state, it was felt that it is also important to adopt a single user interface standard across all school divisions. In some states in which Internet access has been provided through existing university computing systems, the user interface has varied from site to site depending upon the interface software acquired or developed at various universities. While this has reduced the initial start-up costs for the network, it also complicates the process of developing user guides and providing training on a statewide basis.

Equity

The issue of equity was felt to be an important one for both practical and political reasons. It was felt that the network should be equally accessible for all educators and school divisions, and that the cost should be identical no matter what the geographic location or site. In some educational networks, school divisions near university sites or central servers have been able to connect to the network without charge, while educators in school divisions in more remote areas found it necessary to pay for long-distance calls to access the network. The reasons for this have been grounded in economics, and it is arguably better to provide some access than none at all. However, in Virginia there were already a number of existing concerns regarding equity across school divisions prior to implementation of the network. In any event, in both states a principle of identical costs and connect charges for all school divisions was adopted when the networks were established.

Implementing the Networks

The Virginia Public Education Network (PEN) was established first, when a prototype network of three nodes was implemented in 1989. The following year, in 1990, the network was expanded to eight nodes in major population areas across the Commonwealth. (Spanolo & Henry, 1990) A further increase of three additional nodes in 1991 was based on usage patterns in the preceding year. This network architecture provides a regional server that can be accessed through a local phone call in areas of heaviest use, such as major metropolitan areas. Other areas of lighter use are served through access to toll-free 800 lines. As use increases in a given area, a local server may be installed to reduce connect charges.

The network, referred to by the acronym of Virginia's PEN to emphasize its intended use as an instrument of communication among educators, was based upon research conducted during a prior development effort, Teacher-LINK. Teacher-LINK was a pilot project conducted by the Curry School of Education at the University of Virginia in the mid-1980s to assess the feasibility of linking teachers to the Internet on a statewide basis. (Bull, Harris, Lloyd, & Short, 1989) The positive results of this research effort subsequently led to the mandate for Virginia's PEN.

A phased implementation has been a key characteristic of Virginia's PEN. (Bull, Hill, Guyre, & Sigmon, 1991) The mortality rate for educational networks has been high, in part because the need for support services often outstrips the capability to provide support. In the first phase of Virginia's PEN, a pilot network was established. In the second phase, the software was then revised to eliminate network glitches prior to an expansion to a full-scale statewide system. After a year of statewide use, feedback from educators was used as the basis for development of a revised user interface. Researchers from the Virginia Department of Education and the University of Virginia collaborated closely on a development effort directed by Harold Cothern in this third phase. This phased multidisciplinary effort was intended to ensure that defects in the user interface and transport mechanism were identified before the network was used on a large scale by large numbers of educators. This attention to detail also reduced the personnel and resources required for support of the network in later phases.

Virginia has established a fundamental right of access to the world-wide academic information network, or Internet, which parallels rights of access to educational libraries. Any educator in Virginia's public schools or any pre-service teacher in a university teacher education program can access Virginia's PEN without charge. An on-line manual can either be downloaded or read directly on the network itself. An instructional facilitator at each node provides assistance to teachers and administrators who have questions about the network.

Virginia's PEN is linked to the Internet through a connection to Virginia's Educational Research Network (VERNET), the higher education network of the Commonwealth. On-going coordination and planning have ensured that Virginia's higher education network and Virginia's public school network remain compatible with one another and with the Internet.

The Texas Education Network (TENET) was established in Summer 1991 after extensive planning. Any public school teacher or administrator can obtain unlimited access to the network for a flat fee of five dollars per year. An extensive manual and set of training materials was developed prior to establishment of the network. TENET is linked to the Internet through connections to the Texas Higher Education Network (THENET). (Stout, in press)

The types of services that are available on both networks are similar. Although the following description is a composite of both systems, the two networks are sufficiently similar that educators using one system would probably feel comfortable if they logged onto the network of the other state. Because of the capabilities of the Internet, this possibility is not as far fetched as it might seem. For example, a class of teacher education students at the University of Houston recently logged onto Virginia's PEN via the Internet to interact with a group of teacher education students at the University of Virginia. The opening menus of both networks contain the following types of items.

1) electronic mail
2) electronic news and conferencing
3) archives of documents and software
4) user information
5) customization settings
6) on-line reference manual
7) library menu
8) Internet services

Electronic mail is self-explanatory, although it should be noted that because of connections to the Internet system, mail can be sent to several million users worldwide. The USENET system of newsgroups was adopted as the basis of electronic conferencing in both states. Many conferencing systems require that the user log onto a central host. In contrast, USENET newsgroups provide a distributed conferencing system in which items posted on one system can be automatically distributed to every other node across the network. This system of newsgroups provides more than one thousand existing international newsgroups on every conceivable academic topic. Because some newsgroups on the world-wide system are not suitable for minors, both Virginia and Texas restrict subscriptions to those newsgroups that have an instructional purpose appropriate for a public school environment.

A user information menu provides access to listings of others educators with network accounts, so that it is possible to obtain the electronic address of another teacher, or locate another class with a similar instructional interest. While this capability currently pertains only to teachers within a given state, an effort to develop a national directory is under development.

The library menu provides access to electronic catalogs and databases at universities and at the Library of Congress, while the Internet services menu provides access to information services at Internet locations around the world.

Internet Resources Menu
1) NASA SpaceLink
2) Cleveland FreeNet
3) Geographic Name Server
4) Weather Service
5) Webster Dictionary Server
6) Ham Radio Call Server
7) connect to an arbitrary system (via Telnet)

In the next phase of network development, archives of documents and software will provide access to information servers. The documents posted in various conferences may range from lesson plans to the text of historical documents associated with the founding of the nation. Non-text images such as satellite weather images or digitized heartbeats or other biologic information can also be stored in document archives.

Similarities and Differences

The Virginia and the Texas public school networks share a number of common elements and several differences. In all important respects both networks preserve the option for collaborative instructional efforts among teachers in Virginia, Texas, and other public education systems using the Internet.

Both networks establish an information age landmark by guaranteeing a right of access to the Internet for all public school educators in the respective states. Both networks establish a system that is linked to the respective higher education network (Virginia's Educational Research Network and the Texas Higher Education Network) in each state. Both networks are funded through legislative appropriations to the department of education in each state. Both networks were established through close collaboration and planning between the institutions of higher education and the department of education.

The Virginia network was established through a phased implementation, in which each stage of network development was used as the basis for further expansion in the next stage. Pilot studies in Teacher-LINK were used as the basis for the prototype of Virginia's PEN that was in turn used as the basis for a statewide system. In Texas, a public school network was implemented on a statewide basis in its first incarnation. Texas currently uses terminal servers to provide local phone access, while distributed network servers are utilized in Virginia.

A central administrative model, such as the one in Texas, makes it easier to ensure uniformity throughout the network. A distributed model provides the opportunity for customization and a sense ownership at the local level. A grass-roots approach to ownership can encourage local administrators to become political advocates for the system. (Sharman & Cothern, 1986; Cothern, in press) If the network becomes too fragmented, however, it may become difficult to support and upgrade. In other words, some ownership at the local level is positive, but transferring the preponderance of ownership to local sites may produce an administrative headache. At a future date a mixed network architecture of distributed network servers combined with terminal servers is probable in Virginia, possibly providing the best of both worlds.

Summary

The conclusion that might be drawn from the experience of implementing these two systems is that the specific hardware and the mechanics of implementation do not matter as long as a common protocol is preserved that permits educators in one state to communicate with educators in another state, and with faculty and students at institutions of higher education. This does not imply that everyone should use the same network, but rather that different networks should be based on common conventions that permit them to interact with one another. The alternative is a Tower of Babel in which each network becomes an electronic cul de sac that isolates users on that network from those on other networks.

At one time there was a perception that the Internet could not be easily extended to educators in the public schools. However, as a result of technologic advances and reductions in the cost of hardware, some high schools now have full Internet nodes. The experience in Virginia, Texas, and other states has demonstrated that it is both economically and technologically feasible to extend the academic network of universities to the public schools as well. The long-term costs of establishing public school networks that are incompatible with the existing inter-university network is much higher than the cost of establishing a common system that removes the barrier between public school educators and the academic world of higher education.

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Teacher Training and Telecommunications: From Bulletin Boards to InterNet

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Abstract

Electronic networking is a difficult technology to introduce to teachers and schools, whether it is something as simple as a local bulletin board or the use of a global network such as InterNet. We examine some of the problems involved and discuss potential solutions.

Telecommunications offers exciting learning opportunities and activities for teachers and students at all levels of education. This includes accessing online databases, sharing data and programs, electronic conferencing and discussions, and much more. In the past few years, a number of excellent books and guides have been published to help teachers integrate telecommunications into their classrooms (e.g., Andres, Jacks & Rogers, 1989; Clark, Kurshan & Yoder, 1989; Hunter & Lodish, 1989; Roberts et al., 1990). However, to date relatively few teachers have taken advantage of the possibilities; statistics on applications used in schools always show telecommunications as a very small percentage of all computer usage.

From Bulletin Boards...

In the Educational Technology Leadership program at the George Washington University, we have been exploring ways to introduce teachers and training specialists to telecommunications for a number of years. One major component of the program is a computer bulletin board system that is used in all classes. The bulletin board allows students to interact with professors and each other on a continuous basis. It is used for group discussions, sharing information, the completion of assignments, and distribution of class materials. Like all bulletin board systems, it offers private electronic mail, public message posting and file uploading/downloading.

Use of the bulletin board varies with each class depending upon the particular group of students and the instructor. Students will only use the bulletin board on a regular basis if they have convenient access to a modem-equipped computer, especially at home. The instructor must use the system frequently (i.e., at least one a day) in order to give timely responses to questions and problems. Use of the system is sustained over a long period only if it is fully integrated into a course (e.g., used for assignments or file sharing). Finally, the bulletin board system must be highly reliable and always available.

In other words, there are a number of factors that must be satisfied if a bulletin board or any electronic networking system is going to be successfully and significantly used (Harasim, 1989; Mason & Kaye, 1989). We feel that it is critical for our students to experience a successful model of electronic networking in order for them to subsequently use it in their own classrooms. We also believe that it is important for students to understand the factors that affect the viability of networking so they can deal with them in their own teaching applications.

One of the major hurdles in introducing teachers to the use of a network is the initial signon and usage period. There are three major categories of learning required: conceptual, procedural and pedagogical. Teachers must learn many new concepts and terms, even if they are already computer literate. Introductory books on PC telecommunications are helpful background reading (e.g., Dvorak, 1990; Glossbrenner, 1990). Procedures to learned involve how to sign on, select options, and the detailed steps involved in sending email, posting messages, or transfering files. We have tried to use video to address this kind of learning by showing demonstrations of all aspects of using the bulletin board.

Pedagogy is the most difficult type of learning involved because it often requires students to rethink the traditional types of teaching approaches with which they are familar. For example, electronic networking often leads to online collaboration in assignments and projects. For students who are used to learning as a solitary endeavor, this is new. Use of networks to access databases requires information searching and handling skills that are different from those most students are familar with. Existing textbooks and lesson plans need to modified to incorporate telecommunications activities.

To summarize, our experience using a bulletin board system as part of our teacher training efforts has convinced us that a great deal of learning is necessary to understand how to use telecommunications in the classroom. We believe that the most effective method for introducing teachers to telecommunications is regular and sustained use in teacher training courses.

...to InterNet

We recently have received a grant from the National Science Foundation to investigate ways to encourage teachers to use Internet. This is a challenging problem since Internet is a complex global network that requires considerable computer expertise to use (see Quarterman, 1990). Partnerships between teachers, researchers, and computer specialists are typically needed in order to make use of the system. On the other hand, many school systems could develop the skills and resources necessary if they decided to make significant use of the network.

At the present time, very few teachers know much about Internet and its potential applications in K-12. Therefore, one of the first tasks in introducing the possibilities of Internet in the classroom is to show teachers what is being done in various projects around the country. We have collected video footage of these projects and will include them on a videotape being produced for the project. Table 1 lists sample projects.

Signing on and using Internet is much more complicated than using a bulletin board system. The host computers that support Internet at each institution require the use of arcane command languages (e.g., Unix, CICS) that must be mastered in order to access Internet. Similarly, accessing online databases requires learning the organization and commands associated with that database. For example, Internet allows you to sign on and search the online catalogs of hundreds of university libraries; however, each catalog system has a different user interface, menus, search commands, etc. So learning to use Internet requires considerable persistence and technical competence.

In the long-term, improved interfaces on the host computers that make up Internet are needed to reduce the difficulty of using the network. In the short run, training

Table 1
InterNet Applications in Education

Big Sky Telegraph	Links over 100 rural schools in Montana with university resources and each other
ChemNet	Links chemistry teachers in Hawaii
Cleveland FreeNet	Provides full Internet access to schools in Ohio.
FrEdMail	International "store and forward" email network
ICONS	Simulation in international negotiations based at the University of Maryland
SuperQuest	Ongoing contest for high school mathematics applications based at Cornell supercomputer center.

materials need to simplify Internet as much as possible. For example, we recommend focusing on the minimal set of commands and procedures needed to access and use a single Internet host and application. The full scope of Internet is simply too overwhelming for most teachers to contend with. Building a classroom activity around a single application is sufficiently complex, even for teachers experienced with computers.

We also feel that school-university partnerships are essential for the immediate future of Internet applications in education. Few school systems have the computer and telecommunications staff needed to support Internet. Furthermore, most of the online databases, newsletters and resources available have been developed by or for experts in specific disciplines. Involvement of these experts in school applications is important. It also creates a bridge between elementary/secondary schools and post-secondary institutions.

Conclusions

We have been exploring strategies for introducing teachers to electronic networking in our program for some years. In the context of the bulletin board system we use for classes, the factors that determine success are fairly clear. There are a number of different kinds of learning that must occur over time; regular use for class activities allows students to discover these factors for themselves. On the other hand, moving to a more complex environment like Internet, we feel that a different approach is needed. In this case, the scope and use of the system needs to be simplified. Teachers need to work with university researchers or computer specialists to develop and implement classroom applications.

We also believe that video can be a very useful tool for demonstrating telecommunications applications and network procedures. We plan on further exploration using video in the context of teacher training and telecommunications.

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Using Telecommunications In Teacher Education: A Student Perspective

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Abstract

Telecommunications is creating new teaching opportunities for faculty and students in teacher education colleges. This paper discusses from a student perspective an experimental teacher education course that incorporated into the course curriculum a variety of telecommunications activities, including: electronic mail, class conferencing systems, and national and international conferencing systems. Some of the benefits experienced in this course are that: 1) the students gained experience in accessing and using the "large scale" conferencing systems; 2) the students were exposed to a variety of the topics discussed in the conference; 3) students communicated in a professional and scholarly way with students and faculty of other universities. The paper also notes the difficulties and complaints of the students using telecommunications. This paper would assist those who are planning or implementing a course in telecommunications for teacher education students.

One of the recent advances of technology is the ability to connect multiple computers together over short or vast distances and then to then allow communications. This technology, known as telecommunications, is creating new opportunities in all academic disciplines. The opportunities exist with the traditional classroom setting as well as with the non-traditional classroom setting. For example, it can be used as the primary method of instruction and communication in "distance education" and independent study. It can also used as a complement to the traditional classroom lecture with on-line student discussions, remote electronic literature searches, and electronic announcements and class news. Telecommunications is creating special opportunities for faculty and students in teacher education colleges.

Students who have been exposed to new teaching techniques and new technology are more likely to use the techniques and technology. By incorporating telecommunications into the student's curriculum, the student is not only informed about using the technology, the student uses the technology. The professor is modeling a teaching technique. Through this model, education students are can add a new tool to their "educational toolbox."

In the Spring Quarter of 1991, we participated as students in an experimental course in the teacher education college of University of Cincinnati. The graduate level class entitled "Telecommunications and Education" lasted a period of 10 weeks. Much of the course content focused on innovative uses of telecommunications in elementary schools. The class visited a school that was using a telecommunications in the fourth grade. Class participants read Cliff Stoll's book *The Cookoos Egg*: a book highlighting the threats of an electronic environment by describing a real case. A very important part of the class was to learn about and use: 1) electronic mail (E-mail); 2) class bulletin board systems; and 3) national and international conferencing systems.

This paper is focused on the use of these three tools. We briefly describe how E-mail, class bulletin boards, and conferencing systems were used in this teacher education class. We also discuss the impacts of using such telecommunication tools from a student perspective.

Electronic Mail

Electronic mail consists of sending a message via the transmission of an electrical signal. Many universities, including the University of Cincinnati, have access to an E-mail system called BITNET. Through BITNET, colleges and universities are connected with each other, allowing communication within the United States and between the United States and many other countries. Using BITNET, students and faculty can participate in either one-way or two-way dialogues. In one-way dialogues, the sender sends a message that is stored until the receiver is ready to accept it. The students in our class used E-mail for simple queries from one student to another such as: "Did you understand our last assignment?" Others used E-mail to communicate with students and faculty from different parts of the country. One student used E-mail to discuss future teaching opportunities in various parts of the United States. She sent notes to several E-mail users about their university and the qualifications for hiring in that particular department.

Not only did students use E-mail to interact with one another, they used it to interact with the professor. Traditional student/professor interactions take the form of classroom discussions, telephone calls and office visits. Downing et. al. (1988) reports that many engineering students seldom have any outside interaction with the instructor. His report is illustrative of the norm. Indeed in the classes we teach only a handful of students visit or have any outside contact with the instructor. In Downing's paper he shows that E-mail is successfully used in several engineering courses. He found that qualitatively, instructors received more challenging and thoughtful questions through E-mail. In this case E-mail was especially attractive to off-campus students. Students appreciated the certainty of reaching an instructor through E-mail and time by reducing the need for on- campus visits. The professor of this class is an avid E-mail user and some of his advisees and students use E-mail extensively in their communications with him. Since he checks his mail several times a day, students questions are usually answered through E-mail within 24 hours. This is very convenient for busy professors and busy students and ends telephone tag that sometimes is played for days.

In addition to the convenience issues of student and professor interactions, many students find electronic interchange to be a less intimidating interaction. Formal visits to professors office are often frightening to even the most confident student. In our class, one student used E-mail to discuss with her advisor what classes to take in the next quarter. She found this less intimidating and easier to schedule than formal visits to the professors office.

Bulletin Board

The students in the class also used VAX Notes. Vax Notes is a telecommunications utility that allows an entire class to "conference." Vax Notes is similar to a bulletin board system: notes are posted for anyone to read but there is no face to face interaction nor any need to coordinate time schedules. Students were asked to check Vax Notes at least three times a week. Student discussions on VAX Notes ranged from reactions to class events to policy issues of telecommunications. One event the class discussed was a visit to a local fourth grade classroom in a lower socio-economic neighborhood that was implementing telecommunications as part of their curriculum. Reactions to this trip were positive. In the words of one student: "My reaction on visiting this classroom was one of being impressed with the variety of experiences that the students experienced from one project. An appreciation of telecommunications was the least of the valuable experiences of the schools involvement in the project."

Some students found VAX Notes especially appealing because it gave them an opportunity to organize and develop their thoughts before expressing them. Several students commented that they were more comfortable posting their comments to VAX Notes than expressing them in class. One student explained that many teacher education courses are geared toward extroverts, especially classes held in a seminar type form. It is common in classrooms for a few students to dominate classroom discussions.

VAX Notes provides an opportunity for the less assertive students to reflect on discussions, assimilate and organize their thoughts and then share their ideas through the form of a note. VAX Notes also provides the opportunity to express all of those ideas that come after the seminar or lecture and students occasionally posted ideas that came to them several hours or several days after a class session.

Electronic Conferencing Systems

Finally the students participated in national and international conferencing systems. Samples of conferences students participated in include: CNEDUC-L (Computer Networking Education Discussion List), EDTECH (Educational Technology), and AEDNET (Adult Education Network) networks that are used by participants for various purposes including requesting and giving of information and advice, discussing issues, sharing news; and KIDSNET, a network that promotes email activities, such as key-pals (pen-pals), for kids. There are thousands of conferences in which one can participate.

Using theses systems benefitted the students in several ways: First, the students gained experience in accessing and using the large scale conferencing systems. Each student in the class was expected to sign up for and participate in an electronic conferencing system. Second, the students were exposed to a variety of the topics discussed in the conference from whether a high school computer lab should buy IBM or MacIntosh computers to conference announcements and job postings. Third, the conferences allowed students to communicate in a professional and scholarly way with students and faculty of other universities.

Conclusion

In the final week of class students posted some of their reactions to using E-mail, VAX Notes and Conferencing systems to Vax Notes. A sample of those postings is listed below.

"Vax Notes gives introverts a chance to process information in their preferred way and share their thoughts after they have processed them. By holding a class the way this class was held (seminar and Vax Notes) you are tapping the strengths of both introverts and extroverts."

"I believe the most important thing that I will carry away from this class is the knowledge that so many connections exist....With basic knowledge and perseverance, I have been able to contact foreign countries, databases, colleagues, and home shopping."

Since the course on Telecommunications, at least one other course in this department has used telecommunications in the class. In particular, Vax Notes and E-mail were included in a seminar for Education Foundation doctoral students. Informal discussions with several of these participants indicate the use of electronic communications is valuable.

This would be a deficient essay if we did not mention some of the difficulties and complaints of students toward telecommunications. The telecommunication environment works best for students who have easy access to a computer with a modem. Several of the convenience advantages are moot if using E-mail requires a trip to campus. Students who do not type are at a disadvantage and some students simply prefer to communicate face to face.

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Pacific-LINK: Supporting New Teachers through Electronic Conferencing

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Abstract

New teachers need support during their initial years of teaching. The University of the Pacific is providing that support through a computer-assisted telecommunications system that links new teachers to each other, a group of experienced educators, and to two personal mentors—an experienced public school teacher and a university professor. Preliminary evaluation indicates that new teachers feel less isolated and more professional through their use of the network. Similar communications networks may be useful for consideration in other teacher preparation and new teacher support programs.

When novice teacher Betty faced parent conferences for the first time, she asked for help from the other participants in PACIFIC-LINK and got suggestions from five experienced teachers in just two days—without. having to play telephone tag.

Connecting to the Pacific-LINK new teacher electronic conferencing network via her own computer, which in turn is hooked up through her telephone to the mainframe computer at the University of the Pacific, Betty posted the following "item" on the LINKERS computer conference:

> **Item 13. New Teacher (Betty).** Help! Parent Conferences! I am having parent conferences next week. Any one have any ideas on what to say and how to end the conference to get to the next parent? Any ideas would be appreciated! Thanks, Betty.

Here is a sample of unedited responses to Betty's request for help:

> **13:1) Experienced Teacher 1.** Betty, I usually have a short list of generic ideas, activities for the parents to do with their students at home. When I am ready to end the conference I hand them this paper, briefly review it with them, and thank them for coming. Putting something in their hand and saying good-bye usually works and they feel special because you have taken the time to make something for them. To make it more personal, if I feel that it is needed, I will pre-circle the activities that I feel would be most helpful for their child. Good luck!

> **13:2) Project Director.** AND....you can use your Macintosh to make that list for them! (smile) I always started with something positive about the child.and I always tried to have some examples of the child's work that I could give the parent to take home...same idea as handing them a list, I guess.

> **13:3) New Teacher 2.** BETTY, I'm a new teacher

and this year is my first experience of having conferences with parents and even scarier is having IEP's. One thing that has really helped me is that I make sure I have spoken with the parent/parents at least once before the conference. Then the ice seems to be a little broken. I start off by inviting them to look around the room. I offer them something to drink, I guess to me it makes it feel more relaxed. I liked the idea of sending something home with them and showing students' work. Well, good luck.

13:4) Experienced Teacher 2. I too like to give the parents some samples of their child's work. Also it is important to focus on the positive first then discuss the negative areas in terms of goals you have set for improvement. I find it is most helpful to ask questions and do lots of listening and not so much talking. Good luck!

13:5) Experienced Teacher 3. After many sessions of conferencing, I have found it rather interesting to start by asking the parent or parents a question. Such a question could be—How do you think your child is doing? Another—Do you have any concerns you would like to discuss or how does your child feel about school? You could even ask about the positive things the child seems to enjoy about school. This way you are becoming a bit more aware of the parents' perception of you and school. In Team we always make sure the parent leaves with samples of the child's work, and a very positive comment about the child. If there is something specific we would like home to work on we review this one last time as we are nearing the end of our conference. I feel it is helpful to have the parents work on one thing at a time, and we try to give them a few helpful tips on how to deal with the specific problem. The Parent-Teacher Supply store should have some books on helpful phrasing and/or tips on conferencing.

13:6) Experienced Teacher 3. Since we are now into yet another parent/teacher conference, I spent some time today thinking of ideas that people shared with me that were helpful. One problem I still encounter is that of time. Parents become very irritated when they have to wait for their conference. I try to keep a clock or watch handy. Staying within the time limits is tricky but most helpful when conferences are back to back. Another helpful trick of the trade—Keep an on going folder on each child. Tests and other important papers can be placed in said folder and used as a resource for the year. Third, conference invitations are many times given to those you have had problems or concerns with during the first conference. Using the sample work or tests in the child's folder can be a great boost to a parent's moral during the end of the third quarter. You, the child, and the parent should be able to see some real progress. If there seems to be lack of progress, these samples would be excellent reference material for possible student study teams If this is helpful please let me know. If you would like more specific help just send me a hot wire.

13:7) Project Director. Good ideas! I used to like to keep the original and the edits on papers that the student was writing in that folder...the parent and the student can REALLY see how editing works and helps when you do that!

13:8) University Professor. I just ran across a good article on successful approaches for conferencing with parents that might be of use. It's in the October 1990 issue of the Reading Teacher, pages 174-176. The Reading Teacher is having a regular column this year dealing with ways in which teachers might involve parents more in the learning of literacy abilities in school and at home.

13:9) New Teacher (Betty). Thanks for all the good suggestions....I just finished conferencing—and all went well. I had a computer program called Report Card 2, that I kept track of all my grades and then ran a copy for each parent of their child's grades. This really helped me when some parents were shocked at their child's grades and I could show them on paper that there were some missing assignments or just poor grades and the average was what they earned. I also saved some work in their folders and went over that with the parents. Some had not seen some of their child's work before. All these suggestions have really been helpful to me—Thanks again, Betty.

Betty, along with nine other new teachers, is convinced that the support she has received from Pacific-LINK has really made her first year easier. The Pacific-LINK project, is partially funded as a grant from the California Commission on Teacher Credentialling and the California State Department of Education as one of thirty five California New Teacher Projects.

The first year of teaching is typically a lonely and frustrating experience. Even an exemplary teacher preparation program cannot completely prepare new teachers for the demands they will encounter. Isolation from other colleagues and a lack of ongoing assistance in learning how to teach makes it hard for novice teachers to gain mastery and a sense of fulfillment.

One effort to provide support for new teachers has been the assignment of experienced mentor teachers to work with novices. But this system has its drawbacks. Mentors may not be in the same school or teaching the same subject or at the same grade level. They may not be familiar with the philosophy presented during the new teacher's preparation program. They may prove to be unavailable at a time when the new teacher needs to share concerns. Without adequate collegial support, novice teachers may join the large numbers of teachers who quit teaching during their first year or shortly thereafter. The Pacific-LINK project described in this paper is an attempt to address some of these limitations and strengthen the mentoring effort.

Project Description

Specific goals of the Pacific-LINK project include:

1. Reducing the sense of isolation that new teachers feel by giving them access to a support network comprised of:
    a. Faculty members at their teacher preparation institution.
    b. Former classmates.
    c. Mentor teachers within the state of California.
    d. Professional educators throughout the United States.
2. Facilitating new teachers' growth by helping them to move beyond concerns of coping with day-to-day survival to issues of reflecting on and analyzing their own teaching performances and the impact of that performance on students, with particular reference to:
    a. Enhancing knowledges and skills needed by beginners to be successful in their initial teaching positions. These knowledges and skills were the focus of their preservice preparation and are targeted for follow-up during the first year of teaching.
    b. Improving the new teachers' ability to teach students who are ethically, culturally, economically, academically, and linguistically diverse.
3. Increasing the positive attitudes of beginning teachers about teaching.
4. Increasing the retention of competent beginning teachers in the profession of education.
5. Preparing a cadre of California teachers who are comfortable and competent in using a word processor and a telecommunications system for a variety of professional, communicative, and personal applications.
6. Providing research data to validate the stages that new teachers go through and the effectiveness of a program of assistance to beginning teachers in increasing the rate at which they go through these stages.

All of the new teachers participating in Pacific-LINK have two mentors, one a teacher experienced in the same grade level, and the other a UOP professor who worked with them in their teacher preparation program. This combination of two mentors provides the novices with both theoretical and practical guidance, assistance and encouragement during their first year of teaching. The triad arrangement stimulates increased discussion of both immediate problems and on-going instructional issues. The mentors write private e-mail to their new teacher at least once or twice a week, and make themselves available (by logging onto the system almost every day) to answer any questions the new teacher may have.

In addition, everyone on the system (over 50 teachers, administrators and university professors) participates in the discussion items, such as the example about parent conferencing, that are posted in conferences. These conferences include:

- THE LOUNGE — a general conference in which items may be posted on any subject.
- LINKERS — a conference in which educational and project issues are discussed.
- MINDSET — a conference for concerns involving classroom management.
- CULTURE — a conference addressing multicultural issues.
- MENTORS — a conference for project mentors to discuss support issues.
- FEEDBACK — a conference for formative and summative project evaluation.

Although initially selected by the project directors, content is responsive to new teachers' needs since any participant is able to post discussion items relevant to their questions, interests, and experiences. New conferences can be developed based on participants' requests.

Pacific-LINK participants can also communicate with persons in similar projects across the country through Internet, a network of connected electronic mail systems linking most universities in the United States.

One major advantage of communicating in this manner is that the teachers can do it at their own convenience. They can connect to the system any time, day or night, and leave their questions or comments. Others may answer those questions or comments when they have time, so the elements of geographical distance, schedule difference and personal time preferences are eliminated. No telephone tag! Participants may also send copies of instructional or other written materials so they may receive help, or share materials they have found useful.

All project participants are provided with a personal computer, modem, appropriate word processing and telecommunications software, and training in the use of the telecommunications network. Additional training sessions in the use of personal productivity tools (word processors, spread sheets, etc.) and educational software are offered, but not required. The system software used to enable the Pacific-LINK project is CAUCUS, an interactive conferencing program created by Camber-Roth and distributed by Metasystems Design Group.

Preliminary Evaluation

The participants' comments indicate that the sharing of ideas and problems with others has relieved the isolation that all teachers typically experience and expanded their horizons. For example, the following unedited comments, downloaded from one of the conferences, illustrate the typical reactions of new teachers, experienced teachers, and university personnel involved:

> **Experienced Teacher 1.** Pacific-Link has really enriched my knowledge and my personal growth as well. I enjoy reading what other teachers are attempting to do/battling to do/working to do. I've learned some more about the computers, too. It has not changed my philosophy of education (I don't know if anything could change my philosophy of education, though!). As far as my personal life, I spend a lot more time with my computer these days!
>
> **New Teacher 1.** I am glad this program was started and I think its a big help to a first year teacher. I hope to see it continue. It has helped me to become familiar with the computer. It has also helped me in communicating with others who can help or are having similar difficulties. It makes it so easy to get help fast.
>
> **Experienced Teacher 2.** I think this is a most interesting communication tool. In my opinion we are beginning to have people respond more openly to topics they would probably be hesitant to delve into. It is easier to communicate true feelings and/or beliefs in the privacy of your own computer than it is in person. To me this seems easier and more private than a telephone conversation. Here there are no interruptions, and you allow yourself the pleasure of staying on one topic until you exhaust either yourself or your idea bank.
>
> **New Teacher 2.** I was excited to be involved with this project because I have found that the classroom can be a lonely place at times. I feel isolated from other professionals in my field. This project has given me the chance to talk with other professionals who I can bounce an idea off of, gripe to, or get a new idea from. The best way for me to generate excitement about teaching is to talk with other teachers. Since this project began, I've walked away from my computer with a new idea every time. Those new ideas are the one thing that is going to keep me thrilled about teaching.
>
> **New Teacher 3.** It's so great knowing that am not alone in my own little teaching world. And the ideas that I have read far have been wonderful. Plus, using this system really gets my mind going so that I can think of new and exciting ideas that I can bring to my classroom.
>
> **University Professor 1.** This is really a great way of opening up the communication lines as teachers, faculty, mentors, etc. can exchange ideas, suggestions, and whatever else is of interest and importance while having the advantage of being able to compose as we go!
>
> **New Teacher 4.** I have really found this project to be very enjoyable. I really look forward to turning on my computer each day to see what's new. I also agree that I feel more open to ask questions and respond to items through the computer. I am also excited that I am learning more about computers! This is a great opportunity for all teachers and I hope some day all teachers can have the opportunity of communicating through their computer. What a neat way to strengthen our teaching practices! Thank you for this opportunity.
>
> **New Teacher 5.** One of the things that I like most about the communication link is that you can communicate with other teachers as often as you like without playing telephone tag. I seem to spend a great deal of time outside of teaching trying to reach people to get or give information. This is a much more efficient and fun way to communicate!
>
> **New Teacher 6.** This is a great way to do that teacher

talk that we normally have to stay at school until 5 doing, going from room to room talking to other teachers. I like all the discussions that go on and all in all, I'm very glad to be here!

Experienced Teacher 3. This is great we're able to talk to teachers and find out new ideas. I really like it.

Experienced Teacher 4. This thing gives me hope that the profession will connect in big ways that will help us connect more kids to school....As I see it, our greatest challenge is to find ways to re-do this thing we call education in such a way that we elevate the level of participation by the clients—our students. It has only been since the middle 50s that we as a nation have WANTED to keep more than half our students there until the completion of high school..however, we're —for the most part— still doing things the old way...maybe if we can talk to each other more often (and philosophically) through this medium, we can affect the changes necessary.....(Oh ramble...ramble)...Bottom line—I think that educators having the opportunity to communicate maybe the most important component to restructuring the system to meet the needs of all students. Thanks for permitting me to participate.

Experienced Teacher 5. Pacific-LINK is a wonderful project and I hope that it continues. I feel like I am one of the lucky ones because I have communicated with so many people through this system. I also have been in 3 classrooms to help out, because of my communicating with others on-line. I really enjoy working with beginning teachers (guess that's why I am teaching in a credentialing program) and I find this project a terrific way to work with others.

University Professor 2. I love getting mail. It feels like I'm at summer camp waiting for news from home. I think it has helped new teachers feel that they are not alone—if that's all it ever does (and of course it isn't) then that alone will have been a great contribution. Teachers need to talk to each other, in any way, in any medium. This is one way.

Experienced Teacher 6. How does "Communication with the Total Education Community" sound? Because we are corresponding with new teachers, experienced teachers, and teacher educators we keep getting and giving new and fresh ideas to each other. I think it is exciting to be part of a program that will keep us all non-stagnant. The teacher educators are able to get an idea of what is going on in the "trenches". Experienced teachers can get fresh ideas of how to do something they have done a thousand times and new teachers can learn and hopefully sidestep some of the mistakes experienced teachers have had. It has given me the opportunity to gather ideas and get to know people from a wider perspective than I would if I only talked to the teachers in my school. I think I have been bringing in ideas to enrich my class and others at my school.

At the end of the 1990-1991 school year, The Southwest Regional Educational Laboratory conducted an independent evaluation of all California New Teacher's Projects. One portion of this evaluation included a survey in which the responses of Pacific-LINK participants were compared to the responses of teachers in other CNTP projects. The survey addressed the quality of professional support provided by project mentors. Pacific-LINK participant responses ranked favorably when compared with the other projects. All of the Pacific-LINK new teachers responded with a 6 or higher on a Likhart scale of 1-9 in response to the question, "To what extent has the support met your needs as a new teacher?" Overall project statistics indicated that 82% of the new teachers responded with a 6 or higher to that question. 100 percent of the Pacific-LINK teachers indicated that they planned to continue teaching during the 1991-1992 school year.

Conclusions

Even a comprehensive pre-service teacher preparation program has its limits. Research and practice indicate that new teachers need support during their initial years of teaching. The University of the Pacific is providing that support through a computer-assisted telecommunications system that links new teachers to each other, a group of experienced educators, and to two personal mentors—an experienced public school teacher and a university professor.

The electronic conferencing system facilitates support for the new teachers through the bridging of geographical distances, the availability of a forum for discussion of issues with people whose combined wisdom is both supportive and broad in perspective, the ability to easily share materials and lesson plans created on a word processor by sending them through the network, and the availability to request and receive help quickly.

Definitive results can not be reported as yet because the project is still in its infancy, however, preliminary evaluation indicates that new teachers such as Betty feel less isolated and more professional through their use of the network. Similar communications networks may be useful for consideration in other teacher preparation and new teacher support programs.

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TeacherNet: Student Teachers form a Community of Teachers

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Who has some information on the Gold Rush, help! I have to do a fifth grade unit on it next week. What did I do wrong in that science experiment today—the kids were not supposed to laugh?

Comments like these flooded the ATLNetwork this past school year as student teachers in both elementary and high school setting in Long Beach, Cerritos, and Huntington Beach participated in a unique project called *TeacherNet*. Funded by a 1989 ACE Computer Grant from the CSU system and inspired by Craig Blurton's ASTUTE training for CSU faculty on telecommunications, Dr. Jean Casey, Assistant Professor in Teacher Education decided to see if telecommunication could improve the university supervision of student teachers. The number one objective of the project was to improve university supervisor and student teacher communication. The second major objective was to see if having a computer in their home for sixteen weeks would help students really learn to use one effectively and therefore produce a genuine computer-using educator at the time of graduation.

With a generous loan from Apple Corporation of 15 Macintosh Computers, student teachers used *Microsoft Works* for its telecommunications program and were hooked on word processing, data bases, and spreadsheets without even realizing it. With fifteen copies of *KidTalk*, a talking word processing program for them to take to the elementary school and share with their students, we were ready to begin. The pilot phase of the project began in September 1989 with a training session on telecommunications at the SWRL Chancellor's office lab. Master teachers from Carver Elementary school in ABC school district in Cerritos, University supervisors from California State University Long Beach and six student teachers were all trained in using the ATL Network e-mail and conferencing system. The best part was at the end of the training when the participants took home a Macintosh computer, a modem, some software, and the excitement necessary to motivate them to be the first to go on line. The student teachers won by far and were the first to log on to the system, but everyone else rapidly followed. As soon as everyone discovered how much easier it was to send a message this new way and avoid many attempts at telephone tag, the participation grew. With information put on the system by the project director that included hints for lesson design, activities, and job availability, the participants discovered the value of this resource. At the end of the first semester, all of the participants recommended continuation of the project. In Spring 1990, ten elementary student teachers, five secondary student teachers, six university advisors, seven elementary teachers, the Director of Field Services, the Director of Single Subject training, the Director of Education

Placement, and two Educational Psychology counselors were all on line to support the student teaching process. Results gathered through evaluation by the Director and Elementary school staff and a questionnaire indicated the following accomplishments:

- A community of professionals among preservice and inservice teachers was formed. Student teachers no longer felt isolated in their experience.
- Student teachers reported an increased opportunity to reflect on what they were learning. They had more time at home to evaluate teaching they observed and teaching they did, to think about it, and then to write thoughtful discussion questions and responses to their university supervisor. The number of contacts between student teachers and the university supervisor doubled when compared to a semester without telecommunications.
- The student teachers felt the system was a boost to their self-esteem, they took great pride in their telecommunication accomplishments, and they were enthusiastic about the prospect of continuing to use computers in elementary classrooms when they were hired.
- All participants using the conferencing system were able to discuss in depth topics such as classroom management, lesson ideas, job joys and frustrations, job opportunities, and the most important conference, the lounge where all topics were accepted and welcomed and parties and get-togethers planned and scheduled.
- Finally, the university supervisors all really appreciated the ability to preview students' lesson plans prior to visiting the school for observation. They also found it a great timesaver to be able to be alerted by the student teacher of last minute assemblies or field trips that required scheduled observation changes. In the past, many miles would have been driven only to find out that a schedule change made classroom observation impossible on a given day.

Student teaching has consistently been identified as the most significant element in the teacher preparation process. It provides a great opportunity to apply theory to practice in a more intense and prolonged situation than any prior preparation experiences. Our nation is presently facing a coming teacher shortage and the problems of teacher retention are serious. Fifteen percent of teachers leave the profession by the end of the first year of teaching and another 25% during the first three years. It is vital that a close network of professional support among preservice, inservice, and university teachers be strengthened. TeacherNet accomplished just that strengthening. All participants felt that they knew each other better than they had ever known their colleagues before. The student teachers communicated with the master teacher to whom they were assigned, but they received messages, ideas, and communication from any of the other master teachers on TeacherNet. Some of the students communicated with teachers from other states. The Universities of Virginia, Illinois, and Michigan are just a few others who have student teachers in similar programs. This next year we'd like to get our international exchange student teachers at Winchester, England involved in this program.

The only difficulty encountered in the project was the availability of computers and the need to collect all the equipment and myriads of cords and connections, store them, organize them, and have them ready for the next group. The program is not cost effective. Nor are there funds for the 240 more computers needed to make this program available to all student teaching candidates and all university supervision faculty. However, a number of new students arriving in the program already own their own computer. This means that, for the cost of training, software and a modem, many more students can take advantage of this technological support system. GTE is considering helping us get more phone lines at the elementary school sites, and continued business support should help programs like this grow. Most of all, the benefactors of TeacherNet were the student teachers who were very reluctant to part with their Macintosh and were determined to continue being computer using educators. The elementary students caught the enthusiasm for the computer from them. A video tape of the project was made to help others learn about the project. After filming a segment in the kindergarten where the teacher and student teacher explained telecommunications to 30 kindergarten children, the teacher was heard to comment, "Why, without the computers Miss Oh and I wouldn't know what to do!"

The "Net" result appears positive and we now have more teachers who will be vitally interested in and supportive of the California Technology Project and the integration of technology in their classrooms.

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Making Connections Beyond the Classroom Walls: Linking Teachers and Learners

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Abstract

An advanced educational technology course electronically links preservice teachers with university and elementary school students, teachers, and administrators as technology is integrated into the curriculum to improve teaching and learning. The development, rationale, and background for this course are presented.

Introduction

Technologies are available today that permit both teachers and learners to contact the world beyond classroom walls. Collaborations occur among students and teachers at instructional sites, computer labs, libraries, and residences. Can the process of reaching out to others beyond the classroom be integrated into the processes that seek to accomplish some of the goals of teacher education? What are those goals? Why reach out? Who can be touched? What can happen while reaching out?

This paper is about reaching out, collaborating, sharing, communicating, and then integrating technology into the curriculum to improve teaching and learning. It presents a discussion of the questions raised above, an exploration of related literature, and the development of an undergraduate teacher education course.

Background

The past decade has seen numerous calls for educational reform (e.g., Carnegie Forum on Education and Economy, 1986; Goodlad, 1990; Holmes group, 1986, 1990; National Commission on Excellence in Education, 1983). Each criticizes education but then offers solutions to improve teaching and learning.

Calls have also been heard for the integration of technology into the educational system to achieve that same end—the improvement of teaching and learning. Some call for using technology in combination with current knowledge about teaching and learning to aid in restructuring the educational environment. Sheingold (1991), for example, urges a "synergy," a cohesive, "building of educational goals, approaches, tools, and structures" (p. 27). In Vision: TEST (Technologically Enriched Schools of Tomorrow), educational technologies are recommended to empower teachers to create redesigned and better managed school environments conducive to learning (Braun, Moursund, & Zinn, 1990).

Plans are in progress for change utilizing the power of various technologies. Congress, for example, issued a report assessing technology in distance education and made recommendations for its widespread integration into education (U.S. Congress, 1989). Several states, regions, and localities have responded with elaborate designs infusing technology into the fabric of educational initiatives. New York State (University of the State of New York, 1990a), for instance, released a comprehensive plan in which technology-rich environments are to be created for learners and teachers. One part of this environment will have students and teachers actively communicating and sharing with others via Technology Network Ties (TNT), the state's telecommunication network.

The process has begun. Of the many types and uses of technology, one seems to combine telecommunications, distance education, and cooperative learning (e.g., Dede, 1990). With telecommunications as a powerful tool, distance education is linking individuals to outside resources. Tools are already in place. Internet, for example, is an international network that connects to academic, commercial, and government sites to access people and other resources such as library catalogues and databases. Systems such as New York State's TNT connect to Internet and thus open statewide networks to tens of thousands of sites throughout the world (University of the State of New York, 1990b). Distance education can tap into such systems and free its users from time and resource limitations while encouraging discussions and collaborations among individuals who might not otherwise communicate.

Sharing, connecting, communicating, and collaborating is happening through a combination of such technologies and cooperative learning (e.g., Nattiv, Winitzky, & Drickey, 1991; Office of Research, Evaluation, and Assessment, 1990). By associating the power of distance education with the energy produced by cooperative education, the transmission of information, the sharing of ideas, and the products of collaborations can be potently linked.

Telecommunications, distance education, and cooperative learning projects are developing in classrooms across the country. In *Kids2Kids*, for example, students use telecommunications to write for real audiences outside of their school buildings. In *KidConnections*, history and social science subjects are explored as students from remote sites interact electronically to exchange ideas (Casey, 1990).

Innovative school-university collaborations to link preservice teachers with teachers and students in the field are also developing (Allum, 1991; Pitsch, 1991; Switzer, 1991). Future teachers need substantial exposure to real K-12 students and real K-12 classroom teachers. In addition to on-site visits and student teaching, preservice teachers can now gain access to numerous types of technologies to communicate remotely with students and teachers between visits.

The University of Virginia Curry School of Education uses telecommunications and computing technologies to connect its preservice teachers to students and teachers in the public schools and beyond (Bull, Harris, Lloyd, & Short, 1989). The *STAR* program in West Virginia links West Virginia State College and the Putnam Country School System (Childress, 1991). *TeacherNet* in California links student teachers, master teachers, and university advisors. The University of Northern Iowa has created nine regional centers across the state with which it maintains contact electronically (Stahlhut & Hawkes, 1991). Such partnerships are reporting favorable results. Cochran-Smith (1991) speaks of college/school relations as now being "collaborative resonance" rather than "consonance" or "critical dissonance" because of *Project START*, a technology-based collaborative student teaching effort.

Empowering Preservice Teachers

What potentially can happen if "reaching out" with technologies is woven into the teacher education experience? Why do it? Perhaps the accessing of information, the partnerships, and the collaborative resonance are benefits that only scratch the surface. Could it be that teacher education courses that utilize these approaches might also create learning environments that place the student in the center of the learning/teaching world and empower him or her to become the creator, the one with the tools to make things happen? Perhaps with the student in the center, he or she must autonomously reach out and hook up. Student independence and interdependence may develop and flourish.

Stoiber (1991) found that preservice teachers who participated in a technology-mediated project were more reflective, more responsible, and better problem solvers than their counterparts in a control group. Lieberman and Linn (1991) discuss three components of self-directed learning (topic knowledge, procedural skills, and self-monitoring) and their enhancement and power by addressing them in effective programs using computer-assisted instruction and computer-based information management tools. Perhaps programs that link teachers and learners within and beyond the classroom walls can nurture teachers who assess what needs to be done in education and then use whatever tools are necessary to do it.

Perelman (1991) speaks of the need to reach out to break the mold of previous notions about teaching and learning:

"Learning was an activity thought to be confined to the box of a school classroom. Now learning permeates every form of social activity - work, entertainment, home life . . . Learning was presented as the result of instruction: A linear, hierarchical process where an "expert" teacher would pour knowledge into the empty head of an obedient student. With knowledge doubling every year or so, "expertise" now has a shelf-life measured in days; everyone must be both learner and teacher; and the sheer challenge of learning only can be managed through a geodesic network that links all minds and all knowledge" (p. 3).

It is just such a geodesic network that is at the core of an undergraduate course at Long Island University (LIU) entitled *Making Connections Beyond the Classroom Walls* (*Connections*).

Making Connections

An Opportunity. Long Island University (LIU) is a participant in a New York State Education Department/ International Business Machines (IBM) joint study to improve education with technology. By-products of this project are many collaborative efforts that are growing from the connections between participants. The new course, *Connections*, utilizes a networked equipment laboratory with telecommunications capabilities that was donated by IBM and an identical setup in one of the classrooms participating in the study. It draws upon a relationship with a principal, a classroom teacher and 25 fourth grade students from the Oceanside School District in Oceanside, Long Island. The course is intended to benefit both LIU students and Oceanside students. LIU students become involved with fourth grade students on a regular and intensive basis. The elementary classroom becomes an open laboratory that can be accessed in person and remotely. Oceanside students relate to, share with, and learn from college students who aspire to be teachers in a school much like theirs. Technology enhances and facilitates this two-way enterprise.

Course Description. *Connections* will teach preservice teachers using technology (e.g., telecommunications, video, computers) about technology in the elementary classroom. At LIU, fifteen exemplary preservice elementary education majors have been selected for participation. Contact will be made and sustained throughout the semester with elementary "pals" in the cooperating class. Course content will develop from the subject matter within the fourth grade. Learning will be facilitated by contacts in and beyond the university walls. Materials related to the subjects covered will be accessed electronically and manually. Experts will be called upon via telecommunications, video, and in person. Cooperative learning will be emphasized. At the conclusion of the course, the focus will be on products and outcomes. Teaching modules will be taught to elementary "pals." LIU students will evaluate themselves and their peers.

Prerequisites. Preservice teachers in *Connections* will begin the semester with ability, motivation, and a technology background. These are necessary prerequisites because students will move quickly beyond the basics of computers and technology to a position where they use technology to accomplish goals and objectives in education. All students must have excelled in a required LIU course on computer literacy for educators that covers word processing, databases, spreadsheets, telecommunications, various application software programs, and an observation of children using computers. In addition, students must have a faculty recommendation suggesting that they are capable and motivated to take *Connections*.

Contacts. Face-to-face contacts are developed and maintained throughout the semester between LIU classmates and their instructor and between each student and his or her elementary "pal." In addition, remote contacts are developed, maintained, and nurtured with numerous people and a variety of resources.

Contact via telecommunications begins with each student reaching out to each of his or her primary contacts (LIU instructor, LIU classmates, Oceanside "pals," and Oceanside teacher). Introductory contacts are then made with other LIU participants (e.g., undergraduate and graduate students, faculty, and administrators), other Oceanside contacts (e.g., parents, teachers, and administrators) and others (participants and non-participants in the study). It is expected that non-hierarchical relationships will develop through remote contacts. Deans and superintendents will be as accessible as classmates. It is hoped that the individuals contacted will serve as mentors and resources throughout the course and in the future.

Students also reach out to access information. They use sources such as Educational Resources Information Center (ERIC) on CD-ROM, various on-line databases, and information obtainable through TNT and Internet. Knowledge becomes a "collective resource" to be found and processed by the students.

Reaching out is the first part. Communicating, sharing, building relationships, and creating two-way (and more) dialogues should follow naturally.

Subject Matter

Substantive study is a major component of *Connections*. Students must obtain, read, reflect upon, and respond to a large quantity of materials throughout the course of the semester. The broadest content area comes from the fourth grade curriculum in addition to two recent New York State documents, A New Compact for Learning (University of the State of New York, 1991) and The New York State Long-Range Plan for Technology (University of the State of New York, 1990a). All students begin with these materials and then split into cooperative groups to study more specific topics. Telecommunications, distance education, cooperative learning, and problem solving are studied as subject matter and as tools. Pairs of students will be responsible for mathematics, language arts, social studies, science, and the arts. All students will search for and access information from a variety of sources including telecommunications with experts. Students will discuss their findings amongst themselves and with their contacts.

Some material will be shared with elementary "pals." For example, there are two LIU graduate students who will serve as social studies contacts. One is an elementary school teacher from Alaska. The other is a student completing her educational technology master's project in China. The pair of students working on social studies will communicate electronically with these individuals and then share what they learn with their elementary "pals."

Discussion

Preservice teachers need to understand students and teachers in the schools. Direct contact in combination with remote contact may enrich the college experience in an invaluable way. As relationships build between college students and teachers and students in the field, they can be nurtured and sustained using technologies. Superficial contacts may grow into intensive, integral, and on-going communications.

Technology itself will not improve education. It can, though, offer opportunities for powerful innovations to accomplish some of its goals and objectives. A course such as *Connections* should facilitate preservice teachers becoming autonomous, creative educators for our future classrooms. Preservice teachers need to see themselves as directors, leaders, and mentors to their students. They should see themselves as capable of encouraging education to happen wherever and whenever it seems most appropriate. Technologies are available to facilitate this process. Students in *Connections* must see themselves as creating teaching/learning environments. They must find information, reach out to sources and people, discuss, share, challenge, think, respond. Within such a structure, dynamic learning and teaching are possible.

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Distance Teacher Education: $\Sigma >$ the Whole

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Abstract

The old saying that "nothing is new under the sun" is as true for distance education as for other educational approaches. Distance education has grown consistently to meet the needs of adult learners and working professionals. Thus, it is becoming an increasingly significant factor in the current educational scene.

Distance education, defined as instruction that occurs at a distance from the instructor (Feasley, 1982), or the delivery of instruction at one location while instructional expertise is at another (Evans, 1986), is now presented at a growing number of universities. Through computer-assisted and technological support systems, students bound by geographic or professional limitations are provided with the means of pursuing higher education. Nova University is one such institution providing students with access to post secondary education.

This paper discusses Nova University's entrance into telecommunications as a primary instructional tool. Specific reference is made to the National Cluster delivery system employed by the Ed.D. Program in Child and Youth Studies, as well as to the application of technology to other university programs. Faculty training, cost effectiveness, and programmatic quality are also considered.

Background

As Naisbitt (1988) has suggested, we must have a balance between "high tech" and "high touch" (p.30). What better way to have time together and alone, than through the use of technology in a distance learning setting (Usher, cited in Lauzon, 1991). This is education on the brink; technology tapped and harnessed to bring learning to people who are too busy to attend traditional schools or to those who do not have access to conventional campus environments (Roberts, 1991).

The old saying that "nothing is new under the sun" is as true for distance education as for any other topic. Indeed, accounts of correspondence courses, the earliest form of education at a distance from the teacher, can be found as early as 1728 (Battenberg, 1971). Currently, distance education to meet the needs of the adult learner and the working professional has become a significant factor having impact upon the American educational scene (Rumble, 1986).

A growing number of universities now offer graduate programs in computer-assisted distance education. Distance education is defined as instruction that occurs at a distance from the instructor (Feasley, 1982), or the delivery of instruction in which student learning takes place at one location, while content and management expertise are at another location (Evans, 1986). In many cases, distance education incorporates the use of technology to facilitate communication between students and faculty.

The appropriateness of distance education in delivering adequate instruction has been the subject of much debate. Can students truly participate at an appropriate level and receive maximum benefit from the instruction when interaction with the instructor is partially mediated by technological devices such as computers and telephone audiobridges? This question, which on the surface appears to address the problem, does not take into consideration a comparison of technologically assisted instruction with the value of instruction in the traditional setting, and the subsequent effectiveness of those traditional settings for learning (Moore, 1968; Carroll, 1963).

According to Kearsey (1985), the advent of the computer throws us headlong into an age of learning that is fundamentally independent of time and space, an era Kearsey calls one of "distributed learning" (p.1). Kearsey defines this as learning that takes place when and where the student desires — at home, at the office, on the factory floor, or in a learning center. What better way to enhance this recognition of the need for individualization than through distance education, bringing the instruction or classroom (whatever the case may be) to wherever that student may be.

There are a number of critical questions about computer-based distance education that must be addressed. These questions include pedagogical soundness, quality, and cost effectiveness (Levin, 1986; Dirr, 1987). In this paper, we will use Nova University's distance education programs to illustrate how the blending of a number of different components in distance education programs lead to a total delivery process that is "... greater than the sum of its parts."

Introduction

In 1964, a new university was founded in Fort Lauderdale, Florida. Nova University has grown from its fledgling offering of one Ph.D. program to the status of a major university serving over 10,000 students annually. Approximately one-half of these students now receive their major instruction through the distance learning format.

Distance Learning

The concept of distance learning at Nova University expanded from the "Weekend College" format in 1983, to its current use of high technology to replace many of the more traditional weekend class meetings. The first doctoral degrees in the country to be offered largely through the use of high technology were the Doctor of Arts in Information Science and the Doctor of Education in Computer Education. The number of degrees offered in this electronic format was later expanded to include a master of science degree plus four additional doctoral degree majors.

While not all programs at Nova University offer a degree delivered totally via telecommunications, some programs do require that their graduates become computer literate in their professional area. For example, the teacher education master's programs (Graduate Education Modules) added two computer literacy courses to their list of required courses. Students take an initial three-credit course that stresses administrative applications of the computer and end their master's program with a three-credit computer education course that covers classroom uses and explores emerging trends in technology.

The School of Business and Entrepreneurship instituted a requirement that all doctoral students complete their four-credit research course via telecommunications. Students must have access to a computer and modem over a two-year period to complete this four-part course. Thus, students have electronic access to selected faculty throughout the major part of their program while they become familiar with the capabilities of high technology.

The pedagogical soundness and quality of these programs appears to have been enhanced through the addition of telecommunications as measured by student evaluations. The ability to apply newly developed technological skills to academic and professional settings is seen as a positive factor in advancing student performance.

Based on the success of these efforts, the Higher Education doctoral programs are preparing to offer one of their three-credit seminar areas through telecommunications as a first step toward an online delivery system. Students with access to a computer and modem may elect to take their Curriculum and Program Planning seminar in this manner instead of attending a cluster site.

National Cluster

In February, 1990, a group of 18 students in the Child and Youth Studies (CYS) doctoral program enrolled in the new National Cluster. Major National Cluster instruction is achieved through telecommunications. This term is defined as the use of a personal computer, a modem, and a telephone line to connect students online electronically with faculty, fellow students, and central campus resources. A second instructional design permits students to meet and interact directly with faculty three times annually at intensive 4-5 day seminars. Summer instruction alternates between the Ft. Lauderdale, Florida campus and Washington D.C. and is presented in connection with a five-day Summer Institute.

In addition to the required course work, each student must conduct two practicums. Practicums are problem-solving projects, designed to improve a situation, program, or product in the student's work setting. Students in the National Cluster send their major reports online to their advisers. In turn, advisers review their work online, thus minimizing the response time for correction and evaluation.

National Cluster students must become familiar with the Unix operating system in order to participate in the various online utilities to make the delivery of instruction practical and valuable. This system brings to the instructional experience the application of electronic mail, electronic classrooms, bulletin boards, online conferences, and specific programs, such as Electronic Student, Electronic Question, Electronic Library, and Writer's Workbench, to the instructional experience. Although the students learn to operate in the electronic environment, the focus of their doctoral work is identical to the program presented to students in the traditional format.

In addition to on-site instruction and telecommunications, the National Cluster uses other components to enhance its distance delivery system. Use of the telephone, audiotapes, fax, videotapes, and print materials enrich instruction. However, the major characteristic of the National Cluster is its use of telecommunications for teaching and learning.

Telecommunications

In the following sections, we will describe how Nova University has applied teleconferencing, electronic mail (email), electronic classroom (ecr), electronic bulletin board, and the electronic library in various distance education graduate programs.

Teleconferencing

The use of the telephone for direct contact between individual students and their instructors is used extensively in all of the distance education graduate programs. The telephone provides two types of direct contact between students and faculty: (a) conversation, support, and direction; and (b) direct instruction in several master's-level programs. In the last year, the master's program have been experimenting with the use of an audiobridge for teleconferences, linking the instructor with 20 or more students.

The use of audiobridge technology appears to be working well. CYS programs are now planning for its use with the National Cluster. In 1991, a university committee was formed to investigate which systems best meet the needs of the various programs. The committee has decided to lease time on AT&T, Darome, and Multi-Link systems. This arrangement will enable our faculty and students to gain experience with the characteristics of several systems. A decision will then be made in 1992-1993 academic year to purchase one of these systems.

Electronic Mail

All students in the National Cluster and those in the "traditional" CYS program who request the service, receive free guest accounts for online time. The use of email allows our students with these accounts to send and receive messages from faculty and peers. Students are able to upload papers and assignments into the Unix system. The Unix Writer's Workbench component provides an analysis that allows students to perform editing functions. Students can upload and download their material at no additional charge.

Although the technology cluster has been in operation for slightly over one year, certain advantages have been noted. First, email communication substantially reduces the time required for student materials to be received by an instructor or an adviser. The instructor's evaluation of those materials is then capable of being returned to the student within 2-3 days. As a result, the "round trip" for the submission of student materials and for the subsequent review by the adviser is substantially reduced. Any delay experienced is determined by the frequency with which both student and adviser "log on" to their accounts.

A second advantage is the potential increase in communication between students and advisers. In the traditional clusters, telephone contact between students and advisers must be restricted to the evening hours, because most students and advisers work during the day. Indeed, faculty set aside one or two specific evenings a week for phone contacts. In the technology cluster, a student or adviser is able to leave a message at any time of any day or night. Recipients receive the message as soon as they access their email account. The recipient can be at home, at the office, or even at a conference—anywhere there is access to a computer with a modem.

Responses to preliminary questioning suggest that students in the National Cluster communicate frequently with their advisers as well as with other cluster members. Comparison data with the traditional clusters remain to be collected.

The ease of communication appears to have helped students to develop a cohesive and concerned group membership as evidenced by their behavior both online and at on-site instructional meetings. Also, the computer may provide a less threatening mode of communication. Conversely, since the program is new, we may be experiencing a Hawthorne effect that will disappear with time. We are presently beginning to investigate the effectiveness of electronic mail in increasing student/faculty and student/student communications in our computer-based CYS distance education program, as compared to the traditional cluster. We expect to accumulate sufficient data to provide some answers to this question by Spring 1992.

Electronic Classroom

A significant part of instruction for the National Cluster is done online through the use of ecr sessions. In an ecr, up to 10 students are connected simultaneously with their faculty member for a joint instructional session. The entire session (usually 45 minutes to 1 1/2 hours) is recorded and kept in an online library for later student review.

The monitor screen for an ecr is divided into two parts: the first 14 lines constitute the instructor's "blackboard," the last four lines are reserved as a students' display window. The instructor presents frames of instruction on the blackboard. These frames may be new or previously prepared material. A student may ask or respond to a question by pressing a key. A question mark appears next to his or her name on all monitors, signaling that "a hand has been raised." Students may also store up to four lines of response in a buffer. The student can "pop" the entire buffered comment on the display when called upon.

Between faculty ecr and on-site classes, students develop and execute their own ecr sessions, taking turns in assuming the role of teacher. These study groups are coordinated and monitored by the cluster's coordinator, who follows the progress of the group throughout the program.

By June of 1991, all students in the National Cluster had participated in a minimum of four ecr sessions. The preliminary evaluations were positive, but no data were collected because these were designated as "learning" sessions for both faculty and students. Collection of data on the effective/affective outcomes of ecr learning began in the Fall of 1991. Sufficient data to evaluate these outcomes are expected by Spring 1992.

Electronic Library

Students in the National Cluster can access the Educational Resources Information Center (ERIC) database through electronic communication. This service, which is available at no additional cost to the student, can be beneficial for students who live and work at some distance from a university library. Using this service, students can conduct preliminary literature searches from their homes, print abstracts, and document citations. The preliminary search can be used to refine ERIC descriptor terms, which can then be used in more extensive searches of other databases through Nova's Information Retrieval Service. Students may use this information on their own if they are subscribers to a database service. When a student has located potential references, the sources can be obtained from the Nova library.

The electronic library is still in the piloting stage. While only a relatively small number of students have had the opportunity to use this option, reactions have been quite favorable. Research on this component of the program will begin in 1992, after students have had extensive use of the technology.

Although each element of the program is important and has value in itself, the combination of the various components is powerful. A look at each element reveals the value that could be added to distance learning programs. However, it is only when the various components are combined that the synergistic effects are revealed. In planning an online distance delivery program, it is important to plan the time and use of each aspect of technology.

Faculty Training

One of the less immediate, but very important considerations in implementing electronically-based instruction is the identification of faculty with the necessary skills. In fact, it is almost impossible to locate faculty with both content expertise and telecommunications experience. Therefore, we have had to plan on providing faculty training in the use of technology with special emphasis on telecommunications and the various Unix tools to enhance online activity. As part of the training materials, a *Technology Handbook for Faculty* and a *Technology Handbook for Students* have been developed. A supporting videotape to supplement the handbooks is disseminated as a visual technological support.

Cost-Effectiveness

The application of technology to instruction has proven to be somewhat cost- effective to both students and Nova University. National Cluster students are spared the monthly airline and hotel expenses incurred by other students who reside far from the instructional site. Mailing and telephone costs are also reduced. Assignments may be downloaded online and students employ email as the system of choice in communicating with faculty and fellow cluster members. Tymnet charges are assumed by the University.

To some extent, Nova University benefits financially by the use of technology in its distance education programs. Traditionally, faculty travel monthly to sites throughout the United States. Flight and weekend room and board expenses are partially eliminated by substituting ecr classes, email transmittal, video and audiotapes, audiobridge and bulletin boards as primary instructional modes. Although initial equipment and training costs must be acknowledged, and flight, hotel, and food costs remain during the three extended class sessions, long range savings appear to warrant the continued use of telecommunications as primary instructional tools.

Evaluation

When the first 18 students entered the National Cluster in CYS, they were administered a pretest to determine their level of technological literacy. It is anticipated that this process will be repeated with the second group when it begins. In addition, a parallel second and third postest will be given to the same students so that measures of technical growth can be quantified. Currently, several research studies are being designed to gather academic attitudinal information in a systematic manner and in a controlled environment. This evaluation process should enable us to make some generalizations about (a) the value of the distance education program as compared with the traditional program, (b) the perceptions of students concerning computer-assisted distance education, and (c) the relative quality of telecommunications as an instructional methodology versus the traditionally accepted on-site class session.

Conclusion

The computer-based, distance education component of the Child and Youth Studies doctoral program is still in its infancy. Only small numbers of students and faculty have participated in the program, and adjustments remain to be made. The next step is to conduct research on an expanded student population.

Nova University recognizes the urgent need in the United States to provide better access to education for adult learners, especially as the gap between the necessary job skills and the education of the adult population increases. The greater mobility of our society adds another dimension to that problem. It is important to keep abreast of delivery modes that can provide quality education that will also be cost-effective for student and university alike.

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Teaching the Broader Spectrum of Telecommunications

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Abstract

The paper describes a Four Staged program called *Developing Abilities In Teaching Telecommunication's* (DAITT). Using telecommunications DAITT embarks upon innovative strategies to improve at-risk intermediate school aged youngsters' basic and critical thinking skills in mathematics, reading and technology. Stage One involves research and development of ideas so that telecommunications is presented in a motivating and creative way to teachers and eventually through the teachers to their students. Stage Two describes the inservice training component. Stage Three involves a real technological problem given to seventh and eighth graders to jointly solve using telecommunications. Stage Four focuses on assessment.

According to the Carnegie Council on Adolescent Development (1990), those in the 10 to 15 year-old age group can be considered on their way to becoming productive citizens in our democratic society or are unfortunately, at their turning points toward a diminished future. In addition, American youth are suffering from pervasive intellectual underdevelopment. In fact, on average our 13 year-olds are behind their counterparts in other industrialized nations in mathematic and science achievement. The Council also reports that many 13 year-olds lack essential critical reasoning skills. Furthermore, according to Cheney (1990) those students who make it to college are "poorly prepared in the humanities - and in mathematics and physical sciences as well-and once in college, they do not take introductory courses that fully introduce them to the challenges and pleasures of these disciplines" (p. 33). Both reports concur that middle school aged students are at a critical time for development and that innovation, not status quo approaches can "cultivate wisdom that a democracy requires" (Cheney p. 52).

The City College offers the only Technology Teacher Education Program in the entire City University of New York system. City is also uniquely positioned geographically to serve a large minority student body. It is located in the heart of Harlem and graduates more minorities than any other institution offering Technology Education in New York State. City's Technology Education Program has embarked upon an innovative effort to improve at-risk intermediate school aged youngsters' basic and critical thinking skills in mathematics, reading and technology. The theme used to address the at-risk student is telecommunications. The program is called Developing Abilities In Teaching Telecommunications (DAITT) and is now entering its second year of outreach.

DAITT's Four Stages

DAITT's approach toward realizing a broader spectrum of telecommunications includes four stages.

Stage One

Stage One involves forming a team of teacher educators and subject matter specialists to research and develop ideas so that telecommunications can be presented in a motivating and creative way to teachers and eventually through the teachers to their students. Some outcomes of this stage were the development of a hands-on experimenter kit and an alternative way of presenting content by exploring the diverse contributions of minorities.

The hands-on experimenter kit simulates the transmissions employed by commercial telecommunication systems. The rationale for the experimenter kit is to get students actively involved with learning. Research suggests that student learning greatly improves when there is active rather than passive learning. Furthermore, according to Korwin and Jones (1990), just as Dewey supported the use of psychomotor experiences, hands-on experiences can enhance cognitive learning. For under $200.00 per kit, students can simulate and experiment with transmission and reception of laser light and applications of fiber optics. The experimenter kit encourages inquiry into the "mystery" of physics, electronics and information transmission systems. This type of hands-on learning is geared toward helping students understand abstract scientific and mathematical ideas. In mathematics for example, students hone their problem solving strategies by proving the "inverse square law." This "law" can be visually illustrated by hands-on experimentation. Students can calculate the reduction of transmitted light energy per square unit of surface area as the distance increases.

An objective of DAITT is to explore diverse cultural contributions to telecommunications, thus ensuring the inclusion of minorities. Many cultures have contributed to long distance data communications or telecommunications. However, technology texts provide little if any reference to these contributions. Many texts designed for adolescents specifically state or imply that long distance data communications, began in the early nineteenth century. For example, Understanding Technology (1989) inappropriately designates Samuel Morse's telegraph of the 1830s as the "earliest telecommunication technology" (p. 199). These interpretations are at best limiting. The following are a few suggestions to broaden the spectrum of the evolution of telecommunications. There are biblical references to people blowing horns signaling danger from afar. Africans used drums to transmit data long before Samuel Morse. Native Americans used smoke signals before America was "discovered." In fact, our own American history from the eighteenth century tells us of long distance data using binary coding, "one if by land two if by sea." Minitel, the mass scale interactive telecomputing system of France, is presented to further enhance an international perspective of telecommunication.

Stage Two

Stage Two is increasing teacher awareness through inservice education. General training involves a telecommunications literacy effort given in the form of workshops. As a result of this training teachers will be able to participate in Stage One of the project. A more intensive effort is made for those in the program who will participate in Stage Three. These teachers undergo a more in depth study of telecommunications. Some topics covered include: a history of telecommunications including development and inventions of data transmission, broadcasting, personal radio service, commercial radio service; the telephone system including transmission of voice, address information and control information; telecomputing including basic electronics, telecomputing systems, on-line information services, the future of telecommunications; and the sociological and psychological impact of telecommunications and the environment.

Stage Three

Stage Three involves a real technological problem that seventh and eighth graders from select schools throughout New York State jointly solve using telecommunications. The problem, a Structures Case Study, requires students to research, design and construct a portable survival shelter based on specific physical constraints and specifications supplied by a given Case Study. It involves, but is not limited to applications of science, mathematics, reading comprehension, communications, safety and ethics. The curriculum includes such exciting topics as telecomputing, structural forces, structural design, environmental hazards, human physiology, model building and construction techniques. The participant schools consist of at-risk populations. City College's Technology Education majors act as mentors for select seventh and eighth grade participants. The catalyst aiding the research for teachers is telecommunications including use of the InterNet. The InterNet is a combination of over 3,000 nationally linked networks using the common TCP/IP protocol and is the backbone of the National Science Foundation's NSFNet. The catalyst aiding the research and problem solving strategies for students is NYCENET. NYCENET is the New York City Public School's instructional telecommunications network. It allows teachers and students to pool information, exchange ideas and communicate with the Division of Computer Services and other users. NYCENET's capabilities include bulletin boards, many data bases, teleconferencing, E-mail and gateways to other systems.

A unique aspect of this Structures Case Study is the creation of a vast dedicated data base. The new data base residing in NYCENET assists students with every aspect of their problem solving activities. A great benefit of this type of programming structure is that students apply Boolean search strategies when using the database. These logical search methods are fully transferable to a life long endeavor in education and research. Students can compare findings, download and upload files and drawings, and even "chat" with their fellow students any time on the system. NYCENET also has on-line Grolier's Academic American Encyclopedia for related research information.

Stage Four

Stage Four is assessment and refinement for a possible national model. One of the areas chosen for assessment through a pre and post test design for this study, is reading. The premise is that hands-on telecommunications problem solving activities, Boolean search strategies, comprehension of data bases and the critical thinking necessary to interpret them may improve the ability of students to read independently. The assessment process will utilize two different reading comprehension exams to insure against teacher coaching. To protect from unintentional bias, they will be mixed and administered simultaneously. After the completion of the second running of the assessment exam, student scores will be computed and compared. Student scores from the first administration will provide a base for comparison of student abilities prior to the study. By comparing the scores from the post test administration, information will be obtained about the improvement. There will also be a control group. The control group establishes a baseline for comparison and accounts for the effects of natural maturation.

Conclusion

The goal of DAITT is to turn students toward learning and away from intellectual underdevelopment using a Four Stage multifaceted approach. The program reveals that improving basic and higher level critical thinking skills requires content in a relevant context. Furthermore, in order to include diverse populations of 10 to 15 year-olds, curriculum must be multicultural. Youngsters must be involved and must feel that they are part of the educational process. Telecomputing by itself, like other computing technologies should not be viewed by teachers as a means to an end. Telecomputing must be seen as a tool to access information to solve problems. Consider the potential of having previously at-risk students accept the challenge to take college level mathematics or humanities courses because they have the proper preparation. Further, imagine those same students taking some courses for which they lack necessary information, but proceeding with confidence because they know how to access it by using telecomputing.

Acknowledgements

Support for Developing Abilities In Teaching Telecommunication's (DAITT) is provided by a grant from New York Telephone, a NYNEX Company.

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National Education Technology Information Exchange

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The National Information Technology Information Exchange (NETIE) represents a national database of education and teacher preparation materials designed to promote communication among Schools of Education and selected K-12 agencies. This project is a join venture between the University of West Virginia College of Graduate Studies (UWVCOGS) and the International Business Machines Corporation (IBM). The IBM AS/400 mainframe computer which contains the database is managed by UWVCOGS and is funded by IBM through a $1.1 million grant. It is available to Schools of Education through toll-free telephone lines and Internet.

Underlying NETIE is the principle that communication in education is vital. If education is to thrive, classroom teachers need to be aware of the latest research in curriculum and instruction. At the same time it is important that teacher education programs reflect the ideas and concerns of the classroom teacher. It is imperative that teacher education provide not only a theoretical basis for learning but also an arsenal of delivery strategies for the teacher to take into the classroom. By establishing communication links between Schools of Education and K-12 schools, this principle can be maximized to the benefit of both.

NETIE

To achieve the goal of facilitating dissemination of scholarly knowledge pertinent to the use of information technologies in teacher education and K-12 education, NETIE has four major components.

Information Center

This is a communications hub where participants can obtain information, share ideas, and access a demographic database on projects using technology in Schools of Education. Initial information has been collected from more than 140 Schools of Education projects funded through the IBM Technology in Schools of Education grants.

NETIE Notes

This section is divided into four areas: Op-Ed, Q & A on Tech Tips, Notices of Grant RFP's and Notice of Upcoming Events. Letters to the Editor, editorials, and opinion pieces will be found in the Op-Ed section. Q & A will provide access to technical tips via project directors, IBM technical support, IBM consulting scholars, and outside advisors. Notices of relevant activities such as the meeting dates for professional societies as the Society for Technology and Teacher Education will be announced in the Upcoming Events section.

Colleagues' Corner

This represents a library of case studies, proceedings of relevant conventions, and reviews of new technologies, software, and research dealing with education and technology. Highlighted will be case studies of successful programs using technology on topics such as student teaching, field experiences, internships, and recent graduate mentoring. Selected proceedings from various conferences focusing on the use of technology will be available.

NETIE Journal

We are proposing to incorporate an on-line, refereed electronic journal specializing in articles on the uses of technology in education, based in research methodologies. NETIE Journal's relational database will allow for retrospective searches and referencing capabilities not currently available elsewhere within the field of teacher education.

Summary

The National Education Technology Information Exchange represents a first approach among Schools of Education and the IBM Corporation to make available technology in teacher education principles and practices electronically. Utilizing its relational database capabilities, it is intended to make information readily available across national networks. Thus NETIE hopes to serve as a model for the use of these media.

Acknowledgements

The project described in this paper was funded by a grant from International Business Machines Inc., University Relations. Further information can be obtained by contacting either of the authors.

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Telecommunications for Teacher Educators: Beyond E-Mail

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Abstract

Telecommunications is a growing field of interest for teachers and teacher educators. In addition to providing quick communications through electronic mail, a wide variety of discussion groups and information resources are available through various networks. This paper addresses the basics of subscribing to mailing lists, retrieving files from listservers, and using anonymous FTP for the teacher educator who is already familiar with electronic mail. Examples are included, as well as a brief list of listserver sites of interest to teachers and teacher educators.

Evidence of the ever-increasing use of telecommunications in education is seen in the growing number of articles in special issues of journals such as *Educational Technology* (April, 1991) and *T.H.E. Journal* (May, 1991). The number of papers on the topic presented at conferences has grown as well; at the three conferences sponsored by the Society for Technology and Teacher Education, presentations about telecommunications grew from three in 1990 (Willis & Harrington, 1991) to 11 in 1991 (Carey, Carey, Willis, & Willis, 1991), and 23 in 1992 (Carey, Carey, Willis, & Willis, 1992). Additional evidence of the interest in telecommunications in education is the growing number of state-wide networks. Among the more successful are Florida's FIRN , Georgia's PeachNET (Lowney & Wolpert, 1991), New York's TNT (Stoll, 1991), Texas' TENET (Stout, 1991), and Virginia's Public Education Network (PEN) (Bull, Mason, Robin, & Wayne, 1991).

The general increase in accessibility and popularity of telecommunications for educators, and the widespread growth of education-specific networks, makes telecommunications literacy more important for teachers. Several aspects of telecommunications are useful to teachers, such as exploring libraries on the Internet, downloading files of interest from remote sources, and exchanging information throug electronic bulletin boards and journals. But in order for preservice teachers to be effective users of telecommunications, their teacher educators must be literate in this area as well.

This paper is addressed to the teacher educator who is already familiar with electronic mail and is ready to take full advantage of the other resources offered by educational networks, such as electronic journals, peer discussion groups about research and special interests, and other information services that supply information not locally available. All of these can be accessed from your personal computer at home or in the office. [If you do not use e-mail yet but are anxious to get started, see Updegrove, Muffo, and Dunn's article *Electronic Mail and Networks: New Tools for University Administrators* (1990).]

Issues for Teacher Educators Wishing to Use Telecommunications Resources

The early claims regarding many technological advances are that they will both make it easier to do your work and allow you to complete your work in less time. Unfortunately, this is rarely true, especially during the initial phases of use. In the beginning, when the learning curve seems virtually flat, it is more difficult to do a job with the new technology than without. Learning to effectively use telecommunication follows this pattern. However, though it may seem difficult to master at first, telecommunications offers great personal reward in terms of opportunity for collegial exchange and access to information resources on distant computers.

Beyond the narrow but useful trail of simple e-mail are the broad expanses of the Internet and BITNET, the two common networks in higher education. Although Internet and BITNET are referred to as "networks" in this paper they are more accurately thought of as collections of networks that cooperate to provide access and communication capabilities to users. Both are used for e-mail and the process of sending and receiving mail on the two networks is similar. Other services work differently on the two networks and some services are available only on the Internet.

BITNET is the older of the two and works much like a traditional mail service. You send an electronic message to another address on the network and the recipient responds by sending a message back to you. A typical service on BITNET is a "mailing list" that is really not much more than the electronic addresses of people interested in a particular topic such as PageMaker, special education, or instructional technology and authoring languages. When someone sends a message to the "list" that message is rebroadcase to all the people on the list. Several sources of information on the lists, or interest groups, on BITNET are discussed at the end of this paper. Regardless of your areas of interest, there is probably a group communicating over BITNET with similar interests.

On BITNET retrieving files from a computer at a distant university is a two step process. You send a message to the list or interest group requesting a certain file. The computer on the other end receives that request, usually within a day. Then it sends a copy of that file to your electronic address. The whole process generally takes no more than a day or two, and it may take only a few minutes or hours.

On the Internet retrieving a file is more straightforward. On the Internet you can often connect your personal computer to the large computer at your university and then use special commands to connect directly to the distant computer that has the file you want. Once connected other commands let you move around on the remote computer, locate the file you want, and transfer it back to your university's computer. Sources of information on computers that allow "guests" to roam around in them are discussed at the end of this paper.

In exploring the Internet and BITNET, you may find that you require individual assistance. In 1988, Dunn and Muffo suggested that if you are not a "computer jock," you should find someone on campus or in your neighborhood who can provide technical help. Most colleges and universities have computing user services groups specifically for the support and assistance of faculty, staff, and students. In addition, a growing number of colleges of education are staffing their computer centers with knowledgable experts who can provide support and suggestions.

Dunn and Muffo also noted that while the future promises a seamless interface between computers and networks, "current reality is quite a bit seamier." It is not within the scope of this article to provide complete technical information for all computer operating systems. However, we can provide examples demonstrating the general procedures for locating information and retrieving it on both BITNET and the Internet.

Getting Ready to Subscribe to a BITNET Mailing List

There are several thousand "lists" in operation on BITNET. Lists are really interest groups. There are interest groups on BITNET for an unbelievable range of topics - from operating computer information centers to growing roses. Subscribing to one of these mailing lists is relatively easy. "Relative" is the key word. It is not as easy as filling out a subscription card and mailing it, but it is easier than getting a file from a remote Internet computer. The BITNET information services discussed here are called "lists" because they are controlled through LISTSERV, a software package that allows the manager of the list to receive, edit, and post messages to all members of the list.

The ways lists are managed range from total, tight control by the list owner to no control at all. On an *unmoderated list* everything a reader sends to the list is automatically mailed to everyone on the list. *Moderated lists* involve at least some degree of human intervention so that inappropriate material does not clutter up the electronic mail boxes of subscribers. Some very structured lists are really electronic journals, complete with editorial review boards and refereed acceptance of articles.

All you have to do to subscribe to a mailing list is send mail to the manager of the list saying you wish to subscribe. Be aware as you begin to subscribe to lists that you will probably receive large quantities of mail, only part of which will be useful to you. You may wish to limit the number of lists to which you subscribe, or choose only moderated groups (lists) that take care to ensure that only useful, relevant, content be passed on to subscribers.

Moderated general lists for teacher educators using technology include EDTECH, ACSOFT-L, CCNEWS, and PACS-L. EDTECH is a general mailing list on educational technology for "students, faculty, and interested others," where subscribers post requests and comments for other members' response. ACSOFT-L is a list for those interested in developing electronic courseware. CCNEWS is an electronic journal; you receive an issue complete with volume and issue number which includes summaries of articles that are available in downloadable files. PACS-L, one of the first and best electronic journals, was originally created for librarians; however, it contains many articles of interest to teacher educators. PACS-L is edited by Charles Bailey at the University of Houston.

Things to Keep in Mind

Please keep the following suggestions in mind before you subscribe to any lists. First, remember how you subscribed to the list. Save the address and instructions in a separate file or print a hard copy. In the future, you may wish to unsubscribe from the group, and this information will be important. The address to which you send your subscribe and unsubscribe messages are different from the address of the list itself.

Second, please note that some lists are very active. If you save your mail on the university mainframe and are not careful, you may exceed your available storage space on the system. It is best to save important messages to a separate file so that they are no longer in your mail queue, and to delete the rest. Some telecommunications packages also allow you to copy and paste text that appears on your screen, you can copy and paste important messages directly into your word processing program where you can edit and organize them. As I (DW) read my mail I always capture it on the premise that it is easier to delete than retrieve. Before logging off I delete extraneous mail files. Periodically, after double checking that I have copies of items I want to keep in files on my Macintosh, I delete all old mail files in my mainframe storage area. After I have logged off I usually reopen the captured text file and organize the data. First, I delete all the extraneous material such as instructions to "Press return for more." Then I organize. For example, messages are posted to the PageMaker list about printer interfaces, available fonts, printing tabloids, spacing problems, and the like. When I read a new topic I open a new file, then cut and past the message to a new file. As additional news related to that topic comes in, it is also added to the file. These various files are temporarily kept in a PageMaker Mail (month/year) folder on my Macintosh hard disk. Periodically I remove the folder contents to a floppy and redate the folder on the hard disk. This keeps my hard disk from filling up and it also forces me to organize. When I save to a floppy I may also combine a number of files into related folders or disks so that I have a floppy that contains files related to a particular topic such as converstion problems. This facilitates finding specific PageMaker information later. I save CCNEWS and other serials in folders on floppies using filenames that indicate the title and date (i.e., CCNEWS 5(1), 91)

Subscribing to a BITNET Mailing List

This section will give general instructions to join the CCNEWS list, owned by EDUCOM, the major national organization for academic computing in higher education. This information is for users of the VAX/VMS mainframe operating system; to use this on another operating system such as Unix or VM-CMS, you must use the appropriate mailing conventions for that system!

In the following section, information in bold type should be entered into the computer.

First, log in to your account and enter the MAIL utility. Prepare to send mail by entering **SEND**. At the "TO:" prompt, enter:

```
IN%"LISTSERV@BITNIC.BITNET"
```

This message thus goes to the listserver software at the BITNET address: BITNIC.BITNET. If you later decide to unsubscribe, you must send the message (*Signoff CCNEWS* is required for this particular list) to this address. Remember, this addressing convention is appropriate only for VAX/VMS systems. For example, if you are using a Unix machine, you should use the address **`LISTSERV@BITNIC.BITNET`** by itself. The exact way you indicate where you want the message sent will vary from system to system, but the address, LISTSERV@BITNIC.BITNET will remain the same.

It is not necessary to enter anything at the SUBJECT prompt; however, you may enter **`SUBSCRIPTION`** if you wish. At the MESSAGE prompt, enter:

```
SUB CCNEWS Yourfullname-Institution
```

Be sure to enter your actual first name, last name, and institution, instead of the generic terms shown above! You do not need to include your e-mail address because that is automatically included in the header of the message you send. After you send the SUBscribe message, you will soon receive an acknowledgement from the manager of the list confirming your subscription and giving you an overview of CCNEWS. In the future, you will receive new issues as they become available. The acknowledgement from the list manager may come back to you the same day you send the message, but some managers handle their list less frequently. Your acknowledgement may not arrive for days or weeks in some cases; and in others you may simply start to receive files from the list.

Retrieving Files Through a Listserver

The actual material you receive from a list varies considerably. Some lists, for example, receive comments, long and short, from subscribers and then forward all relevant comments in their entirety to all list subscribers. Other list, in contrast, do not send the full text of every contribution. For example, each issue of CCNEWS contains a detailed summary of each of the articles that are available for downloading from the list. You thus do not get every article published in this electronic journal. To retrieve the full text of an article that interests you, another step is required. You must send an e-mail message to the list containing the following text:

```
get filename
```

where filename is the file you want. The listserver interprets that command and sends the file to your e-mail address. Keep in mind, however, that messages to subscribe or unsubsribe go to the listserv software on the computer where the list is maintained. Messages such as the one above (get filename) go to the list address itself. For CCNEWS that address is CCNEWS@BITNIC. Failure to keep the list serve address and the list address straight causes subscribers and managers much grief.

After you subscribe to CCNEWS, you can get general instructions as well as a list of all the articles available by sending a second message to the above address containing the following text:

```
get Articles Index
```

It is best if you only send one command per e-mail message.

Retrieving Remote Files on the Internet Using Anonymous FTP

If your university has access to the Internet, you can receive and send messages from the lists on BITNET. There may, however, be differences between the address you use for a list on BITNET or Internet. For example, the address of the listserver that handles the PACS-L list is LISTSERV@UHUPVM1 on BITNET, but it is LISTSERV@UHUPVMA.UH.EDU on the Internet. Internet addresses generally include the institution (UH stands for the University of Houston), and the type of organization (EDU=education).

Although Internet users have access to BITNET, the reverse is not true. If your only access is to BITNET, you will not be able to use the Anonymous FTP procedure described in this section.

Many files are available through another method of transferring information. Many systems allow users to log in anonymously from a remote site to browse and retrieve files using the Internet file transfer protocol (FTP). The process is referred to as "Anonymous" FTP because you login on the remote computer using "Anonymous" as your ID. You generally give your e-mail address (e.g., dwillis@jetson.uh.edu) as your password. FTP transfers a complete file to your directory on the mainframe computer at the university, instead of to your mail queue. With some special procedures you can transfer large files such as computer programs.

In order to use FTP, you must have the address of the remote system you will be exploring. Through the use of e-mail you are probably familiar with Internet standard name addresses, but it is important to note that Internet nodes also have numeric addresses which may be used instead.

The following is a sample session using FTP to retrieve help files and a list of FTP sites. (An FTP site is usually a storage location on a computer attached to the Internet. Remote and local users can access this storage location (subdirectories on a disk drive) to retrieve files.) In this example, information in bold text should be entered by the user.

After you have logged on to your computer you enter the FTP command and the address of the site to which you wish to connect. In the example below the number address is used, but the name address, which is HYDRA.UWO.CA, could also be used:

```
FTP 129.100.2.13
```

The computer will respond with something like:

```
JUDY.UH.EDU MultiNet FTP user
process 3.0(102)
Connection opened (Assuming 8-bit
connections)
<HYDRA.UWO.CA MultiNet FTP Server
Process 3.0(12) at Tue 14-Jan-92
6:27PM-GMT
FTP>
```

Once you receive the ftp prompt, you can log in to the remote system using the following steps. You should enter the information in bold type, and press <RETURN> at the end of each step:

```
ftp: login
Foreign username: anonymous
<ANONYMOUS user ok. Send real ident
as password.
Password:  Youre-mailaddress
<Guest User logged into PUB:[000000]
at Tue 14-Jan-92 18:2
8, job 128d.
<Directory and access restrictions
apply
```

To list all the files or subdirectories in any directory, use the Unix—style list command **ls**. To change to another directory or subdirectory, use the Unix-style command **cd**. In this example, the information we want is in the directory called LIBSOFT. To change to that directory, enter:

```
FTP>cd libsoft
```

The computer will respond with:

```
<Connected to PUB:[000000.LIBSOFT].
```

Since you only want to view the files with information about FTP, you can restrict the LS command so that it only shows files containing the character string "FTP." To list the files containing information about FTP, enter:

```
FTP>ls *ftp*
```

The computer will respond with the following information:

```
<List started.
binaries_ftp.txt
ftp_guide.txt
ftp_help.txt
ftp_how_to.txt
ftp_sites.txt
<Transfer completed.
```

To retrieve a file, enter **get** followed by the file name. For example, to retrieve the file ftp_guide, enter:

```
get ftp_guide.txt
```

The computer will ask you to specify a local file, which is the name it will be stored under on your home machine. For this example, we'll use the name "FTPGUIDE." Enter the following information at the prompt:

```
To local file: FTPGUIDE
```

The computer will respond with something like:

```
<VMS retrieve of
PUB:[000000.LIBSOFT]FTP_GUIDE.TXT;1
started.
<Transfer completed.  7972 (8) bytes
transferred.
```

You may now either transfer more files using the procedure described above, or you can exit FTP by issuing the QUIT command:

```
FTP>quit
```

A file named FTPGUIDE will soon be available to you in your own directory. This particular file contains information on FTP that will be useful to new users. Note too that several other useful files are available from this source. You could, for example, get the ftp_sites.txt file to look for other sites with files of interest to you, and you could get the ftp_how_to.txt file for detailed directions on how to use FTP. Most university systems have ways of printing files you have received over the Internet or of downloading the files to your personal computer. The procedures for printing and downloading vary considerably from one location to another and will not be dealt with here.

The following is another example of how to retrieve a useful file using FTP. Dartmouth College maintains "a merged list of the LISTSERV and manually maintained lists on BITNET and the Interest Group lists on the Internet" (Coats, 1992). To retrieve this file with FTP, connect to the site by issuing this command:

```
FTP DARTCMS1.DARTMOUTH.EDU
```

At the ftp prompt, enter the following steps, pressing <RETURN> at the end of each line:

```
ftp> user
Foreign user name> anonymous
Password: your e-mailaddress
```

Then, to change to the directory where the file is stored, enter the CD command:

```
cd siglists
```

You can then use a command to list the contents of the file on your screen. The name of the command will vary from system to system.

As always with FTP, specify the name you'd like to use when the information reaches your own account as the local name. To get information about available mailing lists, enter

```
get listserv.lists
     or
get listserv.short
```

and specify the name of the local file you'd like it transferred to when prompted.

To leave FTP, enter;

```
quit
```

Please remember that this information is specific to a VAX/VMS operating system. While the FTP site name will be the same, commands may differ slightly if you use another operating system like Unix. You can enter ? or **HELP** at the FTP prompt regardless or your operating system if you are not sure how to proceed. In additon, subdirectories that can be accessed remotely through FTP often have a file called READ.ME, that contains useful information about the files you're transferring. To get that file you would use CD to move to the subdirectory you want to check and then enter the following command:

```
get read.me
```

Once the file is transferred to your home computer you can read it on your screen or have it printed.

Useful Information and Electronic Addresses

Addresses of lists that may be of interest to teacher educators include the following. When sending e-mail to one of the lists below be sure to use the electronic address conventions appropriate to the operating system you use!

Name: ACSOFT-L
Address: LISTSERV@WUVMD.BITNET
Subjects covered: All aspects of academic computing

Name: CCNEWS
Address: LISTSERV@BITNIC.BITNET
Subjects covered: Campus computing newsletter

Name: DEOSNEWS
Address: LISTSERV@PSUVM.BITNET
Subjects covered: Distance education

Name: EDTECH
Address: LISTSERV@OHSTVMA.BITNET
Subjects covered: educational technology

Name: EDUCOM-W
Address: LISTSERV@BITNIC.BITNET
Subjects covered: Technology issues of interest to women

Name: PACS-L
Address: PACS-L@UHUPVM1.BITNET
Subjects covered: Library computer systems available, including CD-ROM databases, CAI, and hypermedia information.

To subscribe to any of the above, mail the following message to the address of the list given above:

```
SUB Name of list  Your full name
```

Getting Information on BITNET

Although BITNET merged administratively in 1989 with CSnet to form the Corporation for Research and Educational Networking (CREN), BITNET still functions the same way as before the merger. To get information on using BITNET, send messages to LISTSERV@BITNIC.BITNET containing these lines:

```
get BITNET userhelp
get BITNET servers
get articles index
```

If one message with three commands is problematic, send three messages, each with one of the lines above. To receive a list of all available interest groups and newsletters available for subscription send "`get list global`" to the same address. Please be aware that this file contains more than 200 pages of information.

Getting Information on The Internet

The Internet Resource Guide is published by the NSF Network Service Center. To receive a copy, call the NNSC at (617).873-3400. Or, you can send an e-mail message to `resource-guide-request@nnsc.nsf.net` to have a copy mailed to you electronically. Additionally, the information is available by anonymous FTP at the site named nnsc.nsf.net, in the directory called resource-guide.

A Final Comment

Though it may seem confusing at first, subscribing to mailing lists and retrieving files with FTP is an invaluable skill, as it exponentially broadens access to colleagues, information, and resources.

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Information Age Innovations: Online Teacher Enhancement

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Abstract

An online professional development course, *Telecommunications and Information Access*, offers educators the opportunity to earn graduate credit, learn about an emerging technological field, and interact using a telecommunication network. The course includes electronic mail, computer conferencing, remote database searching, and large scale distance education information. Students reported positive response to the course and the technology as an effective way to learn material otherwise unavailable to them. They were pleased with the immediate feedback for their lessons. They also express concerns about the costs, technical difficulties and general lack of support for implementation for telecommunications in education.

Introduction

We are reminded every day—in the media, as we bank, and throughout the routines of lives—that the information age has arrived. Politicians and policy-makers constantly remind educators of their duty to introduce students to the tools of this new era. Unfortunately educators are seldom given the time to become comfortable, to experiment and to practice integrating these technologies into their lives and classrooms. This paper describes an innovative use of information age technology in the professional enhancement of educators and explores the potential for modeling the use of technology as both the medium and the message.

Educators face continuing demands to become proficient with technology in many forms. New teachers are expected to leave the university with knowledge in this area, and practicing teachers are often required to use technology with which they are unfamiliar. Yet most new teachers, even those who have taken a course in educational technology during their preservice training, report they are not comfortable with the technologies (U. S. Congress, 1988).

Information technologies are now available to achieve two goals simultaneously. Telecommunications can provide educational opportunities not previously available to learners; for example, it is now possible to overcome distances, interact with model teachers and experts, and reduce turnaround time for collegial interactions. Examples of traditional courses offered online have recently been discussed in the literature (Harasim, 1989; Hiltz, 1986; Romiszowski & de Haas, 1989; Smith, 1989). In perhaps a more exciting occurrence, the technologies themselves provide an opportunity for educators, regardless of location, to become familiar with the new media in with personalized activities, so that the technology becomes almost invisible within the learning environment. Thus can one course provide theory, literature, and applications within the context of modeling the technology.

Description of the Course

The University of Oregon and the International Society for Technology in Education (ISTE) offer an independent study course, *Telecommunications and Information Access for Educators*. The course introduces educators to current classroom and personal uses of computer mediated communication (CMC), databases, and distance learning.

CMC, defined here as communication across distances using personal computers, modems, phone lines, and computer networks, has several unique characteristics. It provides instantaneous communication, access to previously unavailable communities, multiple participation in activities, and cultural sharing by opening a window to the complexities, cultures and peoples of our world. Two important features provide richness in the use of CMC: it is essentially a medium of written discourse with the spontaneity and flexibility of spoken conversation, and it is a powerful tool for group communication and cooperative learning (Kaye, 1989).

The course is offered entirely online using the information technologies described, which assists teachers in learning the technology and in receiving feedback for assignments. The course was informed by adult learning theory and sensitivity to the myriad needs of busy professionals. Students are responsible for their own learning of this complex and emerging technology. They are are required to design individually useful activities to demonstrate proficiency and understanding as they practice integrating telecommunications into their daily curricular activities.

Educators can earn four graduate credits from the Oregon State System of Higher Education. The credit has been used for salary increments and has transferred to other universities as part of requirements for Master's and Ph.D. degrees. This course represents a departure from other online courses since it has been approved for graduate education credit and is available to individuals in almost any geographic location. Each student has one year to complete the six individual lessons and final project.

GTE/Education Services Educational Network provides the electronic home for this course. Participants exchange electronic mail, interact using computer conferencing, follow scavenger clues and search remote databases online, while offline activities require reading and response to articles and books that represent current literature in the field. Students are encouraged to look critically at the field, identifying appropriate uses and current obstacles to implementation. They must learn the technical skills of connecting hardware, learning software, uploading, downloading, and file transfer while they work through the individual lessons. The course covers mail and conferencing, curricular integration and unit plans, distance learning, remote database searching, and special education applications of the technology. Each lesson contains online activities and offline reactions to the readings. A final project is designed by the student in consultation with the instructor.

Research Method and Questions

We are dealing with a newly emergent phenomenon, with few examples of this type of course currently in existence for professional development. The concept is new and "everyone involved is a pioneer. No two educational institutions have organized their programs the same way" (Roberts, 1991, p. 20). It is therefore important to look carefully at the situation as it evolves.

The case study is particularly suited to research in this situation as it allows us to document the evolution of online courses, gather relevant data from participants and also provide description of these contemporary events. As future inservice and preservice activities are developed, this description will inform planning, implementation and further evaluations.

Students taking this course interacted with their instructor regularly using electronic mail, telephone, fax, and traditional postal service. I archived correspondence, compiled field notes on telephone interactions, and stored electronic mail on disk. I solicited participant reflections during the data gathering phase; additionally, I conducted informal interviews.

Since any researcher filters her results through personal experiences, it is important to explicate my personal interests in this study and the lenses through which I view the world. My personal research and teaching agendas have focused on CMC and distance learning for the past five years. I designed this course, created its materials, and have taught it during the initial year. I have been in contact with students on an almost daily basis both sharing successes and monitoring difficulties. Clearly I have ownership of this online course and a deep personal commitment to this type of professional development for educators.

The questions that guided this study include the following:

(1) What types of educators have taken this course and for what reasons?

(2) Does lack of face to face interaction change the nature of the connectivity with the instructor, with fellow students, or with support services?

(3) In what ways does increased and immediate access in the independent study course enhance student/teacher interaction and course completion beyond typical correspondence courses?

(4) Is the online professional development course a useful tool for learning this type of information? Does it increase comfort in the student's personal use of this technology?

Discussion

After one year and over 30 enrollees, I have some general information with which to begin my reflections on this course. Some students enrolled, but never began the course. These nonstarters represent almost one-third of the total number. Feedback from these individuals has been difficult to obtain; however, it is possible that the amount of work involved was simply overwhelming. One student, who already had completed a Ph.D. degree, commented, "There is more work to these ISTE [Independent Study] courses than to any graduate work I've done anywhere."

The remaining two-thirds of the students have either completed the course or are moving rapidly through the lessons. This represents a higher percentage of potential completions than typically found in most independent study courses, which ranges from 30 to 50 percent (Holmberg, 1988). The evaluations and interviews with those working on the course or those who have completed it have been generally positive; however, many suggestions for improvement were made.

I will present information gathered during this initial year by discussing each research question and then offering some general implications from the results.

Research Questions

1. What types of educators have taken this course and for what reasons?

During the first year of the course more than 30 educators from around the world enrolled in the course. They represented elementary, secondary, and university institutions, and came to the course with experiences as administrators, district level personnel, classroom teachers, and teacher educators. Their knowledge of telecommunications ranged from complete novice to a few with considerable telecommunication experience.

Their reasons for taking this course were as varied as their experiences. Many live in relatively isolated communities with no access to university courses. Others made comments such as "My university doesn't offer any course like this, and I want to know about telecommunications" or "I need to learn this type of thing on my own, in the privacy of my own home and have no resources." One stated, "I am hoping that I will learn more about telecommunications, the theory behind it, some of the research, and a lot of potential activities." One woman took the course out of curiosity and because "I was so happy that a woman is teaching this type of course!"

2. Does the lack of face to face interaction impact the connectivity with the instructor, fellow students, and support services?

This question represents a significant issue because the drop-out rate for traditional correspondence courses is extremely high, often due to lack of consistent and immediate interaction (Schrum, 1991). Concern for student satisfaction and support must be part of any independent study course, but CMC might prove to be a mediating influence in distance learning.

Most students stated the lack of face to face interaction was not a problem and a few identified advantages to this medium. As one said, "Thanks for putting up with my frankness! Maybe I can be more direct BECAUSE I can't see you?" Another responded, "I also just thought what a great system for the deaf, for whom regular phone calls are not an option. This system is so silent!" One student summarized her feelings after the course, "It's weird contacting people you never see or know in person; you develop images about what they look like, but it's neat not knowing AGES."

A few wished for an opportunity to communicate in a traditional face to face manner. I had the chance to meet six of the students at various conferences and meetings around the country. All expressed responses similar to this student's: "Now I can see a smiling, friendly face when I read the messages you send and it is easier to write back to you." Photographs of all instructors of ISTE Independent Study courses are now included in descriptive brochures.

One problem exists with an independent study course and many of the students recognized and commented on it. Each student works at his/her own speed and timeline; some students completed the lessons out of sequence if it was more personally relevant. At any one time only one or two students would actually be doing the same lesson and the chances of them having the same needs or interests was small.

To overcome the lack of interaction with peers, I established an electronic coffee corner for informal discussion. This helped a bit, but the conferencing system used on GTE's network, CAUCUS, is often confusing. More important, the students were highly motivated to keep their time online as brief as possible due to cost factors. A few of the students did establish e-mail interactions regarding possible projects for young children as a result of the coffee corner, but this remains an area of concern. Lack of collegial interaction, supposedly one of the benefits of computer medicated communication, was mentioned repeatedly.

ISTE provides additional support through its Independent Study office and students are able to have procedural issues answered quickly. Questions regarding grades, transcripts, and missing pages in packets are handled by one identified support person, which also speeds response time. In addition, GTE offers an 800 number for support or to report computer difficulties. Students often commented that the support systems were adequate, friendly and accessible.

(3) In what ways does increased and immediate access in the independent study course enhance student/teacher interaction beyond typical mail correspondence?

Overall, students appreciate the immediate feedback available by electronic communications. Students repeated comments such as "I liked the rapid response and frequent interaction with the instructor. She was very understanding and encouraging." "Feedback came immediately via e-mail and always contained overall evaluation of assignment along with some comments on specific aspects of the assignment." "The instructor was very helpful if I became confused about the lessons. Her feedback was the reinforcement I needed to continue."

I consider these comments evidence that some of these students might have dropped the course if they could not get clarification, encouragement and feedback in a timely fashion. As one student put it, "Thanks for the conversation this morning. You have gotten me back on track! I feel much better."

Naturally my students had almost continuous daily access to me by e-mail. To attempt to compensate for the inability to drop in during office hours, I provided my home and office telephone numbers. Students were encouraged to call if the situation required voice communication or they could not wait for an e-mail response and over 50 percent did so. Several commented that the e-mail worked fine, but knowing they could reach me gave them the confidence to problem solve on their own.

A relationship between a teacher and a student is necessary in any educational setting and this is extremely important for online courses. The immediacy of response does not translate into immediately established trust and friendship. Although my students and I were in constant communication, each student moved at his/her own speed in establishing this relationship. It was helpful and important that the first lesson required introductions, humor and some acknowledgement that the educator was in the forefront of this emerging field.

(4) Is the online professional development course a useful tool for learning this type of information? Does it increase comfort in the student's personal use of this technology?

Students reported this was a positive and rewarding experience for them personally. One student said, "I feel that what I learn depends on the amount of effort I put into the course, not upon the format. The independent study format enabled me to take a course I would not have ordinarily been able to take." Another said, "I'll say in all honesty that it's taken some getting used to! The thrill of finding messages awaiting me when I log on has not yet worn off. " A third commented, "My district is very pleased that I am taking these units! Your course has served as a valuable resource for all of us."

Yet, many of the students identified problems for the profession as a whole. They reported that they had few colleagues with whom they could discuss these telecommunication activities. One student reported, "Not many people I associate with are knowledgeable about telecommunications, much less have the opportunity to implement it into their work environment." Another said, "I plan on encouraging other faculty to become familiar with telecommunications."

Further, while these students had forged through difficulties with the hardware, software and networks, the overwhelming conclusion was that other teachers might not be able or willing to accomplish the tasks. One teacher educator said, "It's not totally user-friendly or dependable, and it has its costs. I'm not sure it will gain wide spread use among teachers until those negatives can be minimized." Another commented, "My response at this point is that telecommunications has a great deal of potential in a number of ways but it must become much easier if it is to be useful to most teachers."

Implications

Overall responses to the course have been extremely positive. Those who have finished the course reported satisfaction with the information and skills they acquired; more important, they are pleased with their ability to complete the course. Each person appeared to develop his/her own personal style to complete the requirements. These varied extensively and several students commented on this flexibility as a major strength of the course.

According to the participants, other positive aspects of the course include creative scheduling, ability to rapidly turn in assignments and receive feedback, and the freedom to negotiate projects that were personally significant. The reading and support materials were current and relevant.

Some aspects of the course did not work well. The lack of cohesiveness and group interaction, as mentioned, was a drawback. Frustration with technical difficulties also resulted in occasional discouragement, as many people had trouble uploading lessons, and the manual provided by GTE was not as clear as desired by the students.

Another difficulty was the cost involved. Costs for credit and materials were quite reasonable for a graduate course, but the additional telecommunications charges were considered high by many students. Each student received a free account on the network, but the connect charges, especially from rural areas, mounted rapidly for those learning a new activity and system.

Students from countries other than the United States and Canada have had even more difficulty in their connections. Teachers in Japan, Taiwan, Africa, and New

Zealand have attempted to take the course and have had to postpone or cancel due to enormous charges for packet switching data from outside the U.S.

Recommendations and Conclusion

Data provided by students in the *Telecommunications and Information Access* online course have given new insights into the needs and goals of educators who took this innovative professional development course. From their words and suggestions, and my own experiences, I have three recommendations for future expansions in this area.

First, educators are to be encouraged to explore emerging technologies in ways that are relevant and meaningful to their lives and professional responsibilities. Those willing to try new methods of professional development are to be applauded, of course, but must also be rewarded with time to learn and experiment, and with appropriate financial reimbursements.

Second, further development of appropriate and innovative courses is necessary. This study provides a few insights from a limited number of participants, but more information is clearly needed. It would be helpful to have follow-up activities with these educators and possibly to assist them in training others or in implementing their new skills. Equally important is the expansion of experiences our preservice teachers have with technologies. An internship in a technology rich classroom would be a significant step in this direction.

Third, the educational community would benefit from further research regarding the nature of educational activities conducted entirely online. Is this a short-lived phenomenon? In what ways do educators who learn in this manner implement the technology into their professional work? What is the nature of communication and interaction online and in what ways is it similar or different from other communications?

We are only beginning to find ways to facilitate integration of new technologies into the classroom for the improvement of teaching and learning. We have frequently not put into practice what we know about good education and innovation when attempting to bring about change. Use of technology in teacher education and professional development activities may provide the time necessary for educators to gain confidence, identify appropriate uses, and experiment with specific techniques for their own classrooms. This study is one step in understanding the process of change and the requirements for implementation.

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Purdue and Prodigy as Partners: Reducing the Isolation of the Beginning Teacher

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Abstract

After several unsuccessful efforts to create an environment to prepare its pre-service and first-year teachers for technology in the classroom, the Purdue University School of Education has established a partnership with Prodigy Information Services. This partnership has resulted in the development of a Purdue bulletin board on the Prodigy system which offers faculty and students dramatic possibilities for professional development. The presenter, the Director of Computer Services for the Purdue University School of Education, will demonstrate Prodigy and the Purdue bulletin board.

Overcoming Continued Failure

For the past several years, the Purdue University School of Education has been searching to establish an environment that will encourage its faculty and its graduates to better integrate technology into their professional strategies. Faced with some faculty who consider the overhead projector as high tech, campus budget cuts, and belt tightening by the private sector, it was decided that the time had come to take advantage of that which could be done, rather than to continue to wring hands and lament over that which couldn't.

The first step in the process has been to squeeze every available dollar to purchase a computer and a modem for each faculty member as quickly as possible. These efforts have provided this technology for about 90% of the current faculty over the past 4-5 years, with a goal of reaching 100% support by the summer of 1992.

The second step was to develop a need for faculty and students to use the technology. Despite the fact that it should appear obvious to each professional educator that (s)he should possess a technological competency that at least approximates that of the students, it has proven difficult to motivate some faculty members in this area. However, compelling incentive was recently provided by Marilyn Haring, Purdue's new Dean of Education, when she declared that she will now transmit via BITNET most of those communications which heretofore would have been transmitted via paper. This mandate has indeed encouraged faculty members to turn on their computers, and to use them for something other than word processing.

The most recent, but hopefully not last, step has been the consummation of a partnership agreement between the Purdue University School of Education and Prodigy Information Systems, a national commercial telecommunications leader with over 1,000,000 members. As a result of this agreement, a Purdue University bulletin board is now available on Prodigy for access by students, faculty and alumni nationwide.

The Agreement

After failure to secure funding for continued operation of its own communications node to BITNET, the Purdue School of Education contacted Prodigy Information Services to determine if a cooperative arrangement could be established. The impetus for seeking such an arrangement was the desire to provide faculty and students as broad a range of on-line support as possible, without burdening the School with the management overhead associated with maintaining a private service.

Because Purdue University's 35,000 student on campus population and tens of thousands of alumni worldwide represent a substantial block of new users, in May of 1992 Prodigy personnel indicated a genuine interest in pursuing a possible agreement. Discussions began immediately and continued through July of 1992, with representatives from both sides communicating via telephone and e-mail in an attempt to determine what such an agreement should include.

Once the general concept was agreed upon, then the representatives took the ideas to their organizations for refinement. This process took two months within Prodigy, and four within the School of Education. The additional time within the School was required to develop consensus among faculty members and administration, and a fifth month was required to channel the agreement through University level administration. The entire process of formulation lasted from May through December 1992.

Both sides agreed early on that the Purdue School of Education would need its own bulletin board on the service, over which the School would have control. There were few conflicts between the two sides on this issue, and the development of the bulletin board has been straight forward.

The principal concern from the Prodigy side was the distribution of membership ID's. As a profit-oriented enterprise, control of user rights is fundamental to Prodigy's survival; however, as an academic institution, Purdue requires the flexibility to assign and re-assign user ID's to a continually changing faculty and student body. After considerable review, it was agreed that a block of Prodigy ID's would be delegated to the Purdue School of Education, and that Purdue could manage these ID's within the Purdue "family".

A principal concern from the Purdue side was compliance with University policy restricting association of the University name and/or logo with endorsement of a commercial enterprise. This restriction resulted in an understanding that Prodigy would not be allowed to use its association with Purdue for endorsement of Prodigy, and forbade the School of Education from receiving commissions that could have been realized from revenue Prodigy will conceivably generate from alumni participation in the service as a result of this agreement.

A principal concern of both parties was money. Purdue of course emphasized the potential financial benefits that could be realized by Prodigy through replication of the Purdue-Prodigy arrangement, and Prodigy personnel stressed their need to demonstrate immediate payback. The result was an agreement that established a one-year trial period during which the School of Education would receive six months of free service for each ID, followed by six months charged at the going rate. It is understood by all that this arrangement will be re-negotiated at the conclusion of the first year.

Initial Usage

The principal benefit to the students of the School of Education is access to Prodigy during their student teaching experience. In this capacity, Prodigy serves as a means of communications between students and faculty, and as an added dimension that expands the strategic arsenal available to each student teacher.

Student teachers and their supervisors can send personal notes to one another any time of the day, and know that they will receive a timely response. Additionally, participants can communicate openly via the bulletin board, which should promote shared ideas and/or concerns between students, faculty and alumni. Bulletin Board topics include student teaching, teaching ideas, research, placement, certification, elementary education, science education, job openings, etc.

On-line access to current news, Accuweather, NOVA, National Geographic, Encyclopedia Americana, Consumer Reports, Where In The World Is Carmen San Diego, and several Prodigy managed bulletin boards available just for kids gives Purdue student teachers insight into the educational potential of technology. Student teachers can use the service for personal reference and planning, and, given the expanding availability of the technology in schools, they can also bring Prodigy to school with them for direct use with their students.

Potential Expansion

One of the more intriguing aspects of the agreement, from the perspective of both parties, will be to see how much interest the project will generate among the other eleven schools and supporting agencies on campus. It is anticipated that the University will consider the bulletin board to be an outstanding tool for linking the Purdue family and for broadcasting university news, and that the School of Education will receive a number of requests to include broader university access to its bulletin board. Expanded to include the entire university, topics on the bulletin board could include news from each of the university's schools, as well as postings from the university's news service, placement service, sports information office and office of alumni relations.

The Purdue/Prodigy partnership is an example of how educators can work with the private sector for mutual benefit. Although only in its initial phase, it is hoped that this project will serve as a model that can be easily transferred to other institutions.

PSInet as a Tool for Classroom Learning

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Abstract

This paper presents a description of how the University of Arkansas is using *PSInet* to teach preservice and field teachers how to integrate computer-based technologies as classroom management and networking tools.

PSInet is being used to reach beyond our classroom LAN to teach Arkansas educators how to integrate technology in their classroom practices. That use is not unique as it is the intended use of PSInet. What is unique is the success of strategies we have used to make PSInet an attractive instructional tool for educators teaching in University and median public school settings.

Introduction

Last year, a colleague and I reviewed some literature on teacher retention. That review indicated that Arkansas would have a severe shortage of K-12 science and mathematics teachers within the next five years. Additionally, the review reported teachers' feelings of isolation and their inability to effectively manage classroom variables (records, paperwork, lesson planning, etc.) as two of the of the primary reasons for their attrition. Concerned over this report, we decided to develop and deliver a training program that would address both of these issues.

Over the winter months we developed a 45 hour course designed to provide first through fifth year science and mathematics teachers with knowledge and skills in classroom management and networking strategies using computer-based technologies. During the spring semester, we submitted our course proposal to various administrative offices on the UA campus in hopes of gaining funding for our program. In late April, we gained the necessary financial support from one of Vice Chancellor's, Dr. Gerry Bomotti, to offer the course free to 90 field teachers during the summer and fall semesters. Having gained adequate support for the course, we went about the task of identifying a mode of delivery for our course.

First, we entertained the idea of presenting our course using a traditional lecture and laboratory format and inviting field teachers to attend the course on our Campus. Due to the mountainous terrain of our region, it was decided that daily travel to and from the Campus would pose a significant problem for our students. An alternative would be for us to divide the travel with our students by teaching the course at a central state location. That idea met with its demise when we were informed that we would be teaching classes on Campus five days a week over the entire summer semester. A third alternative presented itself as funding for distance education technologies became available to us.

aving decided that the two-way, audio-visual interactive distance education system would be the most practical and efficient way to deliver our instruction, we were faced with deciding how we would exchange text-based course information and materials with our students on a daily basis. An obvious method would have been over-land or snail mail. Financial and time constraints made this method unacceptable. A second alternative we considered was the use of Internet/Bitnet.

Electronic exchange of information would definitely be less expensive, more efficient, and quicker than land mail; however, we considered that method unattractive when we discovered that most of our students would not have access to the Internet system after the course ended. One of our goals of the program was to keep the students electronically linked to each other and to us after class ended. Additionally, since we were going to teach computer-based networking skills in the course, we did not want to complicate the teaching-learning process by using two different telecommunication systems.

Considering both the nature of our course goals and the need to incorporate the use of PSInet in our IBM labs (need identified at our IBM meeting in Corpus Christi), I asked my colleague, Dr. Jon Pedersen, if he would have any objections to using PSInet as the electronic exchange utility for our course materials or as the package that we would teach our students to use for learning telecommunications networking skills. As luck would have it, Dr. Pedersen informed me that he had over five years experience using PSInet at the University of Nebraska before coming to the University of Arkansas. He also had his own copy of PSInet and used it regularly to keep in contact with faculty on the Nebraska system. Based on his experience and enthusiasm for using the program, it was decided that PSInet would be used for our course.

Practical Considerations for Implementing PSInet

Our first move towards implementing PSInet was to load the needed software onto one of our PS/2 model 25's so that it could be used as a PSInet workstation. We did the same thing at the remote classroom site using a computer we borrowed from our Campus Computing Services office. This arrangement worked in the technical sense of the word, but it was obvious from the start that we were going to meet with limitations that were not going to be acceptable for our long range instructional purposes.

The first problem we encountered was our lack of control over file management. A second problem was the cost of going online several times a day, each day of the week, to send and receive course information. Since we were going to ask our students to send us their daily homework and laboratory exercises over the PSInet system and we would monitor their progress on a daily basis, we realized that the cost of long distance calls was going to be restrictive.

Our resolution of these problems was to obtain a third computer and apply to become a PSInet server station. Using an old Zenith machine that was being removed from a general access lab on Campus, and a hard drive that Dr. Pedersen was able to obtain from another university in exchange for some consultant work, we had the makings for our own server.

How We Used PSInet in Our Course

Before classes began, we loaded our course syllabus, the first week's course handouts, data files that were needed for use with the students' textbook, and a welcoming message describing PSInet onto our file server. Additionally, we set up some initial conference areas and designated easy-to- remember passwords for each workstation. Red was the password for the University of Arkansas class and green was the Little Rock site password.

On the first day of class, we taught our students how boot PSInet from the C> prompt, dial the server and download the course syllabus and the next day's class handouts. We did not go into detail over the technical aspects of PSInet or downloading files. We simply talked our students through the process describing only the goal of the exercise—to get the course information.

Students worked in pairs and groups of three. Only a few had any computer experience. On the second day of class, we had our students register for the class by sending demographic registration information using the PSInet editor to enter their information. This information also served as the class database that students used to become acquainted with one another, and we used it as the basis for our own spreadsheet gradebook.

On subsequent days, we taught our students word processing, database, and spreadsheet applications using Microsoft Works for the IBM. On a daily basis, our students sent us their homework and exercises over the PSInet system. Since we were trying to facilitate networking skills, we had students at both ends download each other's work each day and provide each other with critical feedback concerning their progress on specific projects. Students learned to use PSInet with little trouble or resistance.

A final project in the class served as the final examination. The final project required each student to use word processing, a database and spreadsheet to develop a proposal to seek funding and support for the use of PSInet in their specific school. Each proposal identified (1) practical uses for PSInet in the student's school, (2) the name, address, and phone number of a teacher, librarian, or other school personnel (and the principal) that agreed to assist the student in implementing PSInet, (3) a teacher training strategy/program (goals, objectives, timeline, etc.), and (4) a specific list of resources (money, computers hardware and software, phone line costs for 15 minutes per week, someone to act as file transfer manager, etc.) needed to establish and maintain a PSInet workstation in their school.

During the last week of classes, our students exchanged and critiqued the proposals. Their proposals were sophisticated to say the least. Together, we are currently in progress of helping our students establish their own PSInet workstations. Interestingly, one of our students accepted a teaching position Jordan, His efforts to implement PSInet in his school are also in progress.

Summary: Past, Present, and Future Uses of PSInet

During the past year, the following projects/tasks have been initiated and/or completed concerning the use of PSInet in the College of Education at the University of Arkansas.

1. Over 90 elementary, middle school, and secondary school teachers have been trained to use PSInet as a telecommunications networking tool.
2. Each of the 90 teachers have written and submitted proposals to their school administrators asking for funds to initiate PSInet in their building.
3. A COE server for PSInet was established on August 15, 1991. This server allows University faculty as well as N.W. Arkansas teachers to use PSInet without long distance call charges.
4. The COE server shadows the existing PSInet server in the state capital. All conferences and sessions available on the state's ARKnet server are now available on the COE server.
5. Contracts have been made with Learning Initiatives in Atlanta. By November 1, 1991, the COE server will shadow the LEARN server.
6. Contacts have been made with two other states. It is proposed that by February 1, 1992, the COE server will be linked with two additional state servers. This will broaden the scope of service to our teachers.
7. As of October 1, 1991, twelve COE teacher education faculty have been trained to use PSInet in their teacher education classrooms.
8. By the spring semester, 1992, PSInet will be used in a joint project between two additional states in the training of preservice secondary teachers.
9. It is proposed that by December 20th, 1991, all Learning Initiatives colleges will be linked together through the COE server.
10. Currently, other grants are being actively sought to enable teachers whose district cannot afford equipment, to provide them with computers, modems, and software to implement PSInet.
11. Currently, other grants are being actively sought to enable other states to join in specific conferences focusing on the needs of teachers in the filed.
12. Currently PSInet is being used at the University of Arkansas to conduct a research project concerning students' use of the system in two countries to study economics.
13. Five COE faculty have received Learning Initiatives memberships. These faculty are: Dr. Barbara Gartin, Special Education, Dr. Jon Pedersen, Science, Dr. Bill Nielson, Mathematics, Dr. Annette Digby, Language Arts, Dr. Jacqueline K. O'Dell, Technology/Teacher Training.
14. Funding has been allocated by our dean, Dr. Roderick McDavis, to send two Learning Initiatives representatives to the Annual Learning Initiative's Conferences in 1991-1992. Faculty will attend the Atlanta meeting next week. In return, faculty agree to provide 10 hours of training (technology integration and/or application) over a twelve month period.

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Graduate Students and Fourth Graders, Connected at Home on a Commercial Telecommunications Service

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A graduate student named Nancy made an interesting discovery about spring fever while working on her telecommunications project. Late one evening at her home, she sat down at her terminal, accessed the network, and typed this message to her fourth-grade penpal Kesha:

> DEAR KESHA,
> I DON'T FEEL LIKE STUDYING
> TONIGHT. I HAVE SPRING FEVER.
> YOUR FRIEND,
> NANCY

The next day, when Kesha got home from school, she read Nancy's message on the screen of her telecommunications terminal. She replied:

> SORRY YOUR SICK, NANCY.
> HOW HIGH IS YOUR FEVER?

When Nancy read Kesha's reply, she called her husband to the terminal. "Look at this," she said. "I can understand Kesha's mixing up *your* and *you're*. But I wouldn't have believed a child could reach fourth grade and not know what *spring fever* means."

Her husband smiled. "I think you're learning as much from Kesha as she's learning from you. Maybe this home-to-home telecommunication is going to become a basic part of teacher education programs."

Computerless Telecommunication, Home to Home

In the teacher education program at Eastern Michigan University, computer-based telecommunication is already in use to make classroom connections between elementary students and graduate students (Moore, 1991). Other electronic penpal connections have been tried, classroom-to-classroom (Newman, 1989; Riel, 1989). But the home-to-home connection established in this project is brand new.

It involves technology developed in France with the national Minitel Network, an interactive telecommunications system that needs no computer/modem connection. The Minitel Network delivers videotex and graphics on a small terminal that plugs into a telephone jack.

Similarly, the "dumb" terminal supplied to subscribers by U. S. Videotel plugs into a phone jack and delivers the videotex and graphics of the Videotel Network. The small box-like terminal has a screen and a foldout keyboard, and it enables the user to send and receive information on an interactive online system (Bigham, 1990).

This technology was first used in teacher education in 1990, and was adapted for home-to-home connections for this project in the spring semester of 1991. During that semester, 53 graduate students in the College of Education, University of Houston, became electronic penpals with 45 inner city fourth graders (Beeler, 1991).

The two groups were connected, home to home, on the U.S.Videotel Network via telecommunications terminals supplied by the company (Hlozek, 1991). It was essential for these graduate students and fourth graders to be on a network that could be accessed *without* a computer and modem. Though some of the graduate students owned computers, none of the inner city youngsters did. In their school, over 90% of the pupils were on free or reduced lunch.

The mostly-suburban graduate students hoped to broaden their horizons by using telecommunications technology to correspond with the inner city youngsters. The two groups got acquainted by writing each other, home to home, in the evenings at their terminals. In this way, the graduate students could try out the usefulness of this state of the art technology in their teacher education program.

From Start-Up to Party

For all of the fourth graders and for most of the graduate students, it was a new adventure to send and receive penpal messages via telecommunications. The network provided an open E-mail type of bulletin board on which everyone could read what everyone else had written. Messages stayed online for seven days. The system allowed answers to be attached directly to messages, and everyone could read the answers too.

Initially, partners were assigned to each other (one fourth grader to one graduate student, with a few graduate students left over to write extra messages). The graduate students tried to break the ice with many different kinds of get-acquainted messages. They introduced themselves and wrote to their fourth grade penpals about books, movies, TV programs, sports, trips, their own children, pets, parties, news, questions, and story starters.

Most of the initial messages from the fourth graders were quite short, sometimes just HI or HELLO. It soon became apparent that many of the fourth graders wanted to receive electronic mail, but they weren't clear on the concept of writing messages themselves. To demonstrate, here are samples of penpal letters (one liners) from three different fourth graders:

> I WANT EVERYBODY TO WRITE ME.
> HI. PLEASE WRITE.
> DEAR PENPAL, SEND ME A LETTER.

Even those fourth graders who were more fluent in their writing stuck to very basic topics. They frequently mentioned their ages, the ages of their brothers and sisters, their birthdays, and even what they ate for dinner.

After the first month of home-to-home connection, the novelty appeal of electronic penpalling declined, and only about half of the fourth graders continued to exchange messages with the graduate students. Therefore, during the second month of the project, about half of the graduate students found themselves writing into a void, with no replies from their assigned penpals.

Most of them did eventually manage to strike up a bit of correspondence with other fourth graders, a few of whom were prolific writers. Nevertheless, all the grad students agreed that the one-to-one penpal ratio was not ideal for teacher-education purposes. Three to five pupils per graduate student would work better than just one.

Also, despite the graduate students' best efforts to lead their penpals toward structured forms of writing like narration and description, the great majority of the correspondence remained informal and expressive from start to finish.

The semester's highlight was a cookie party at which the graduate students and the fourth graders met face to face. The cookie party generated a great deal of correspondence since the children had to tell their penpals what kinds of cookies to bring.

One fourth grader wrote this endearing note about her eagerness for a face-to-face meeting, as well as her cookie preference:

> MY HEART IS SET ON SEEING YOU.
> I THINK YOU ARE GOING TO BE A
> PRETTY LADY. MY HEART IS SET ON
> OREO COOKIES TOO.

Benefits of Telecommunications in Teacher Education Programs

One night near the end of the semester, evidence appeared on the screen, showing the graduate students' opinions of the benefits of the project. It happened when a fourth grader sent this open letter to the graduate students (shown with the fourth grader's spelling and arrangement of print):

> FINISH THIS STORY.
> WHAT TELECOMMUNICATIONS
> MEANS TO ME IT IS SO GREAT, ITS
> FABULOUS, FANTASTIC, TERIFIC.
> ITS A GREAT EXPERIANCE TO US. WRITE
> TO ME TELLING ME WHAT YOU LIKE
> ABOUT IT.

Graduate students started responding within the hour. This first reply came from one who lived across town and hated to drive in heavy traffic:

> I LIKE THE WAY THE NETWORK ALLOWS ME TO GET TO KNOW YOU WITHOUT EVER LEAVING MY HOME.

The next reply came from a student who wanted to become an English teacher. She decided to praise the child's strengths, but also to model the correct version of at least one error (the child's mispelling of *terific*):

> YOU USED SOME TERRIFIC ADJECTIVES TO DESCRIBE OUR TELECOMMUNICATIONS SYSTEM. ALSO YOU DID A FINE JOB OF CENTERING YOUR TITLE. I ENJOYED READING WHAT YOU WROTE.

It's clear that the next respondent was thinking ahead toward her job hunt, and rightly so. Teacher-education programs can schedule students into only a limited number of classrooms and grade levels. So the programs need telecommunications technology to give pre-service teachers contact with pupils at many different grade levels.

> TELECOMMUNICATIONS GIVES ME THE OPPORTUNITY TO GET TO KNOW WHAT FOURTH GRADERS ARE LIKE.
> I OBSERVED IN FIRST AND SECOND GRADES, BUT I MIGHT BE HIRED TO TEACH FOURTH GRADE.

These graduate students' messages highlight three benefits that telecommunications can add to teacher education programs:

(1) convenience of time online with children, rather than time in traffic, driving to schools;
(2) opportunity to observe children's composition skills and to interact instructionally; and
(3) acquaintance with a wider variety of grade levels and socioeconomic groups.

The U. S. Videotel telecommunications technology is available for home-to-home connections, but it is not yet widespread or familiar. So the first thing that teacher education programs need to do is to acquaint their own students with the potentialites of this technology. Also the logistics of using this delivery system need fine-tuning, so teacher educators need to plan their telecommunications projects carefully. But if instructional technology continues to grow and improve as expected during the 1990s, the prognosis looks positive for greater use of home-to-home telecommunications in teacher education programs.

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Electronic Networks for Inservice Teacher Education

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Abstract

An electronic Bulletin Board System (BBS) is used to link geographically-dispersed doctoral students who are also full time teachers. The specific purpose of the network is to help each participant write a major "position paper" required for the comprehensive examination leading to doctoral candidacy. The participants use the BBS to share drafts of their papers and to receive feedback from one another and from their faculty advisors and committees. Progess on the objectives of the project is viewed against the background of criteria for predicting success of electronic networks, and factors affecting its outcome are identified.

We report on our experience with an electronic network that we use to link doctoral students in the Mathematics, Science, and Instructional Technology program who are also full time teachers with one another and with us. The specific purpose of the network (in addition to the general goals of improving communication among teachers and establishing linkages among their pupils) is to help each participant write and edit a major position paper required for the comprehensive examination leading to doctoral candidacy.

Collegial Links in Graduate Teacher Education Programs

Continuing professional development is frequently required of teachers by state law or collective-bargaining contract. For various reasons, many teachers choose to connect their professional development to graduate degree programs. In addition to coursework, graduate programs typically require completion of one or more major papers (master's thesis, doctoral dissertation proposal, dissertation) based on either library research, field research, or both.

The Need for Communication

Such papers are often the most difficult steps for full time teachers to complete. Too frequently, teachers tend to founder at the writing phase_thus the high incidence of professionals who call themselves ABDs (All But Dissertation). While for some the difficulties stem from the twin competitors of doing their best in their teaching and meeting the demands of personal and family life, a major cause, especially in the writing phase, is the isolation in which they typically work. Just as teachers' lack of collegial contacts in their teaching situations can lead to feelings of alienation and burnout (Rothberg, 1986), so the isolation at the research-and-writing stage often leads to frustration, avoidance behavior, the need to request extensions of time limitations for completing degree work, and eventual abandonment of the effort. In many cases, geographical isolation exacerbates the problem.

Alleviating the Isolation of Teachers in Graduate Programs

The intellectual isolation at the writing stage can be partially overcome by providing students with regular opportunities to meet in groups to receive constructive feedback on their writing, from instructor and fellow students. Due to infrequent meetings and time constraints, this often results in an unacceptably long turnaround time.

Another method for alleviating teacher isolation is the electronic network (Kimmel, Kerr, & O'Shea, 1988). Electronic communities, like all communities, need to have valid reasons for existing, and the participants must share a common purpose. Some communities are formed *for* people rather than *by* the users, and it is not surprising that they are usually shortlived. Riel and Levin (1990) have compared this type of community to a "quick introduction (of participants) at an electronic cocktail party which fails to lead to any further exchange."

For any organization, one can identify factors that affect its usefulness and life span. Philips (1982) analyzed patterns of behavior in educational settings and developed a set of categories, labeled "participant structures," which can be used to study these behaviors. As applied by Riel and Levin (1990) to analysis of electronic communities, the relevant participant structures are:

- **Organization of the work group**, including such factors as number of members, their past experience, and degree of common interest and relationships within the group.
- **Task organization**, including such factors as medium of communication, facilitation of cooperative tasks, and publication of a paper or report.
- **Response opportunities**, including ease of access to network and equipment, presence of social resources, and community context.
- **Coordination and evaluation** of quantity or quality of exchanges on the network.

Riel and Levin (1990) identified factors that characterize successful programs in several categories. We have chosen two categories that seem related to our study: communities formed for university-based research and those formed as teacher networks. Factors identified by Riel and Levin (1990) as necessary for success of these two types of community include:

1. There should be a **shared goal or outcome**.
2. Groups should have a **need for the technology** to further their objectives.
3. Groups that **existed previously** have better chances of survival and success than ones that are formed specifically to use the technology.
4. Each group member should have **easy access** to the technology, and the technology should be **efficient** for the purposes of the group.
5. All partners should have **regular patterns** of mail **access**.
6. There should be a **facilitator** (a systems operator or leader) who helps the group stay on task and helps to evaluate the group's output.

These factors will be used to identify reasons for our project's success or lack thereof.

Description of the Project and Progress Report

We report on a project that combines a writing "support group" with an electronic communications network.

Participants

A group of six elementary and middle-school teachers, all doctoral students in science education, and all at the stage of writing position papers for their doctoral-candidacy examinations, are enrolled in a seminar in science education that meets weekly (occasionally biweekly). The two authors are instructors for the seminar. In their teaching and home locations, the participants are spread over an area approximately 90 miles by 40 miles. They are veteran teachers: four of the six have been teaching for over 20 years. They are midlife converts to the beauty of science and the power of technology: only one has a science background from undergraduate days, and their interest and expertise in technology has arisen in the past five years. One of the teachers has in recent years made technology a major part of her professional activity.

The SpaceMet Electronic Network

The participating teachers and their two instructors are connected to the SpaceMet electronic bulletin-board system (BBS) centered at the University of Massachusetts/Amherst (Wilson and Sternheim, 1991). SpaceMet is an inservice teacher-education project of the Five College/Public School Partnership, an initiative of the Five Colleges (Amherst, Hampshire, Smith and Mt. Holyoke Colleges and the University of Massacusetts. Its primary goal is to enhance the knowledge and skills of middle-school teachers in space-related sciences. As one means to achieve this goal, the SpaceMet project operates its own BBS.

SpaceMet utilizes the MAXIMUS Bulletin Board System. It is not limited to participants in the SpaceMet teacher-enhancement project, but provides free access to the network for all teachers and their students in Massachusetts. It is connected through the FidoNet network to dozens of educational BBS worldwide.

Project Startup

Although the SpaceMet project receives funding from the National Science Foundation, and the SpaceMet BBS is supported by several sources, our project does not receive funding from any outside source; teachers provide their own computers and modems. At the start of our project in September 1991, all participants either owned or had access to a personal computer. Within a few weeks, all had purchased modems and had acquired telecommunications software. The computers used included several kinds of Macintosh, an Apple-IIGS, and several brands of IBM-compatible PCs. The software included a variety of public-domain and proprietary programs. A separate message area within SpaceMet had previously been dedicated for the science education program and has been used for the purposes of the project reported here.

Sharing documents via electronic communication

The specific goals of this project are to enable the participants to upload files containing outlines and segments of the comprehensive-examination "position papers" being generated, and to have them, and the instructors, download these files and respond with feedback, either via the message utility of the BBS or by editing the files and returning them to the author. At the time of this writing (partway through the first semester of the project), all the teacher/participants are regular users of the SpaceMet BBS, and all have at least begun to use the BBS to share their writing. The rate at which various members have geared up, and the frequency and amount of use, have varied considerably, depending on variables such as:

1. rate of generating the document (how ready each person was to write rather than continue research on which to base the writing; how much editing each person does privately before choosing to share the draft; how much time each person has, or chooses to make available, to devote to writing);

2. previous experience with computers and telecommunications;

3. access to a computer and to the network (how soon after the project's inception members obtained equipment and software, how much competition there is for computer access at home from family members);

4. the ease with which a particular computer, modem, and word-processing and telecommunications software can be connected and interfaced.

The most advanced participant has repeatedly uploaded outlines and drafts, with the total length of her (partial) draft now at 62 kilobytes. The least advanced has been communicating with the group via messages for some time, but is just beginning to send the first pieces of a draft.

With only six teacher/graduate-students in the group, it would not be particularly instructive to provide numerical frequency-of-use and volume-of-use data as a function of time as was done by Kimmel, Kerr, and O'Shea (1988). Instead we report qualitative and anecdotal data.

All group members are now active participants, and there are no dropouts. For each member, the length of material transmitted and shared has increased with time since first logging on. There is no evidence that this trend will be reversed.

In addition to the documents being up- and downloaded, there is significant electronic traffic in the form of messages among the group members relating to their writings: sharing of literature references of possible interest to another member, questions and answers about managing the burgeoning bibliographies, and questions and answers about using special features of the telecommunications software. On several occasions some of the more experienced group members have visited others' homes to help them over a blockage in using the network (or over a writing or organizing block)

Participant Structures and their Effects on the Project

It is instructive to refer to the factors listed by Riel and Levin (1990) as important for success of a community. The group of graduate-students/teachers was already an informal community, having been involved in common courses and inservice projects and having conducted some research together. They were at the same point in their doctoral programs; each had as the next task to produce a research paper for the comprehensive examination. Therefore the factors relating to a shared goal (#1) and to previous links (#3) were satisfied. The factor relating to convenient access (#4) was also satisfied, but to an extent that varied among the individual members. The factor relating to regular patterns of use (#5) was satisfied (once each person had the equipment and software in place and functioning). The factor relating to specific need for the technology (#2) was subverted by the weekly class meetings. Participants brought their writings to the meetings, or in some cases sent them to the instructors by "snail mail" (the U.S. Postal Service). Despite objections from the facilitators, this became a pattern (in part because some members didn't have all the necessary equipment at the beginning) which is only now being reversed. As for the factor concerning a facilitator (#6), the instructors facilitated communication within the limits of their own technological competence (well enhanced by the SpaceMet system operators). To be sure, we could have been more insistent in our demands of the teachers, but we are aware of the job pressures upon them as full time teachers, and are sensitive to morale issues, recognizing that undue pressure is uncalled for in dealing with one's own graduate students and would have resulted in withdrawal rather than increased output. In addition, we had to keep in mind that this telecommunications project is a means to an end, not an end in itself. The end is production by the graduate students of quality papers. In principle, we could reduce or eliminate the face-to-face meetings so as to require the use of electronic communication, but that would subvert the purpose of our endeavors.

We can identify several factors that have limited the rate at which this project has progressed:

1. Members acquired equipment and software after the project began, and in some cases have upgraded these during the project.
2. The equipment and software are of various brands and versions, so that standard instructions could not be given;
3. The SpaceMet network actually consists of several interconnected BBS serving different geographical areas within Massachusetts; while messages can be sent to any user on any of the BBS, at the moment files are restricted to the BBS on which they were uploaded. We have partially circumvented this restriction by taking advantage of overlapping telephone local-calling zones, which enable some members to access more than one board.

Conclusions

There is no doubt that the seminar has had a positive effect on the progress of the students' writing. The certainty of weekly feedback from us as well as from peers has kept them writing (albeit at various and variable rates), and the frequent feedback has greatly improved the quality. We know from previous experience with other students in similar circumstances that they are severely "at risk" or vulnerable at this stage. The fellowship and communication of this project have greatly increased their chances of success.

As for the effect of telecommunications on their progress, the impact is less clear. The sizable and increasing volume of communications via messages is significant, but most communications of that kind could as well be carried out by telephone. It should be said, however, that the technological aspect of the project is still in its beginnings. We intend to continue and expand our project. Papers cannot realistically be exchanged and reacted to by telephone. Even brief messages can become prohibitively expensive at greater distances. We have in the pipeline a doctoral student who, after fulfilling the residence requirement last year, has returned to full time teaching in Alaska (but was not ready to engage in writing at this time). This will make an interesting test case for using telecommunications for shared writing projects over much greater distances.

This project should be replicable wherever an electronic network with easy and inexpensive access to educators is available. If all members of a group are within local calling distance of a university's host computer, or if far-flung members can log on through a node at another institution, Internet or Bitnet provide that access. While it has slowed our progress so far, the fact that we have mounted this project with users owning a variety of kinds of hardware and software makes this project more realistic for replicability purposes. It can also accommodate a related purpose—collaborative writing projects among geographically-dispersed teachers.

In principle, all the functions we have described except for editing can also be performed via telefax communication. Bradshaw and Desser (1990) refer to audiographics—the combined use of computer networks, voice transmission, and telefax transfer of print and graphics—as an efficient and cost-effective means of communication. At the present time, fax machines in homes are rare—especially homes of underpaid teachers. As fax-machine prices decrease, paralleling price trends of other technological equipment, this limitation will disappear.

Acknowledgements

We thank Morton M. Sternheim and Helen Sternheim for invaluable help in making the SpaceMet BBS work optimally for the goals of this project. We also thank the participants in this project: Diana Campbell of Bernardston Elementary School, Margaret Inness of the Boston Public Schools, Elizabeth A. Koscher of Chapin Street School in Ludlow, Barbara LaCorte of South Hadley Middle School, Wanita Sioui Laffond of Buckland-Shelburne Elementary School, and Terez Waldoch of Wildwood School in Amherst.

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Educational Connectivity: Networking Operations and Service Delivery Through Computerized Technology

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Abstract

This paper presents the conceptualization, development and implementation of a computerized *Data Bank Management System* (DBMS) within a college. DBMS is a data banking system designed and developed to provide technical resources to college faculty, staff and students in the three missions of the University of Guam. DBMS includes several copyright data bases that standardizes advisement (COE Advisor) and individualizes degree programs through a computerized system (IDP Manager). Currently, a third data base system is being developed for the College to provide administrative and professional decision making capabilities. These capabilities include analyses of trend data on students, College formative and summative evaluation of programs and curriculum, and a 5-year projective budget plan and course offerings. Implementation of the DBMS was sought to help increase faculty, staff and administrative productivity through the use of LAN and WAN electronic connectivity systems.

Background

The Micronesian region of the Pacific Ocean covers a vast territory that is slightly larger in area size than the 48 contiguous United States. This ocean region includes more than 2,000 far-flung atolls, territories and island nations or colonial entities of Pacific rim countries such as Japan, New Zealand, Australia, and the United States. In recent times, these island nations and territories have been in the forefront of international news due to their political aspirations as well as their emergence in the development of their social, economic, environmental and educational systems.

The University of Guam (UOG) frequently serves as the lead institution of post secondary education within this region. UOG is situated on the United States island territory of Guam that is approximately an average of 2-5 hours flying time to many of these islands. The University has helped develop and produce many of these islands' past and current leaders as well as advanced research activities on indigenous language, culture, education and traditions, and, within the context of its broad regional mission to provide technical assistance on an ongoing basis. The island of Guam is the largest in Micronesia covering an area of approximately 212 square miles and serves as the "hub" for travel, development, industry, tourism, and higher education.

The College of Education (COE), one of four colleges at UOG, serves the region in its teacher training needs both for pre-service and in-service education. Beside its on-campus enrollment of Micronesian students majoring in education, the College remains in close contact with well over 1300 other students throughout the region through CBand radio, satellite telecommunication, as well as human network systems.

Given the broad span of the region and the evident need for services on the islands, it has become apparent that UOG needed to take the educational and political lead in the region. Thus, it was necessary for UOG to experiment with innovative methods of technological linkages and service deliveries to bring about some standard level of efficiency in communication. This need has long been recognized and has been creatively addressed by the University of Guam through COE.

Introduction

In recent years, the uses of advanced technology in higher educational institutions have been realized with the onset of computerized systems and sophisticated communication linkages (Lavin & Phillipo, 1990; Alluisi & Staggs, 1990; Pakieser & Corritore, 1990; Molnar, 1990; Watkins, 1991). These systems are ever so crucial in the development of institutions with different characteristics than are traditionally observed. Part of the concerns that surface in such places is the dire need to become linked with other institutions to further knowledge base, advance thinking ideas, and foster collaboration on many educational fronts such as teaching, research and service. The contiguous 48 states of the Union along with Alaska and Hawaii enjoy normal linkages and connectivity without the added burden of insurmountable costs and limited resources encountered by these island entities.

Guam and Micronesia present a very non-traditional communication setting in that informational linkages over a broad span of ocean differs significantly than those found for over land systems. Travel within the region is limited to airplanes and ships. The region is currently dealing with the increasing rate of information exchange for decision making and that which undoubtedly and continuously affect life throughout the vastness of Micronesia. Additionally, given the extreme limitations in technological and human resources, better methods of informational exchange must be implemented to keep abreast with the changing state of Micronesia and how its development will fit the nature of the world today in terms of political, economical, social, and educational developments.

Conceptualization

The conceptualization of a *Data Bank Management System* (DBMS) was first envisioned by a core group of individuals at the University level and within COE. These pioneers saw the critical need for an informational data bank system to rationalize the need to improve curriculum planning, provide for efficient evaluation and management procedures of University academic and administrative operations, and, to improve the overall delivery of student services through advanced technology.

The foundation for such a system has been laid with the initialization of significant system components. Several ongoing activities have become integral to the DBMS. These are the COE Advisor Program and the Individualized Degree Program. Both programs were locally developed with the technical assistance of Eternity Software. The broadest objective of the project was to help make COE's information base a manageable system whereby faculty, staff, administrators, and students could reap the benefits of its efficiency. The bottom line was to get College personnel to use the latest in technological advancements, i.e., computers, to their advantage thereby bringing about greater efficiency in service delivery to faculty, staff, and students.

The concept of DBMS materialized with the hiring of two technical consultants knowledgeable in the conceptualization and development of data bases and management information systems. Resources and a basic plan for computerization of COE were provided by a federally funded Title III Institutional Strengthening Project grant awarded to the University by the U.S. Department of Education. Recognizing the enormous potential for computerization, key faculty and administrators at COE became involved with the technical consultants in the fuller design and implementation of DBMS.

Development

The design of the DBMS was progressive and systematic after extensive research was done to include College personnel and, with the understanding of how each fit into the whole system. DBMS was to contain several databases that could be used by COE personnel for the various different needs identified. Several surveys were conducted to determine the various individual activities of key College personnel who were responsible for major College activities and to provide a description of each personnel's work responsibilities. Staff were interviewed to determine the scope and nature of the work they did and the manner in which they carried out their activities. Faculty were also surveyed and interviewed to determine the types of activities they did that tied in with the concept of DBMS.

The data were extensive and revealing. A better understanding of how the entire College was organized, managed, and operated or functioned was realized with an excellent snapshot of things that could be. This challenge was put in the context of achieving overall operational efficiency and College personnel were more than receptive to the idea of a centralized area for information banking and retrieval. The implementation of such a system was found to be exciting, innovative, and timely.

It took three months for the entire concept to be developed and the plan laid out for its implementation. Tasks identified included: (1) the procurement of hardware and software for the system; (2) the development of user policies to govern use and on-line behaviors; (3) technical training for faculty and staff; (4) the establishment of a software evaluation committee to review and screen acquisitions; (5) hardware and software network distribution policies including licensures; (6) the establishment of linkages with other systems on-island and off-island; and (7) the evaluation of how the system should fit into the overall University network system in the future.

Implementation

After achieving a 90% completion rate on specified projects DBMS now includes Local Area Network (LAN) and Wide Area Network (WAN) systems; an electronic mail program, resource accessibility to printers and program software; remote connectivity with five area projects that work with the Pacific region and Micronesia; linkage with a University satellite telecommunication and distance education system, i.e., Pan Pacific Educational and Communication Experiment by Satellite (PEACESAT); and direct hook-ups to local, national, and international electronic bulletin board systems to enhance curriculum, program, and general communication.

Currently, all of the 27 professional and 8 staff personnel have a computer workstation linked into DBMS. Five remote area projects are also linked into the system through individual modems. Several faculty are individually linked to electronic mail systems and other data base search and retrieval networks off-island. DBMS houses the COE Advisor Program, the IDP, a host of word processing and statistical software, and various other programs for the immediate use of COE personnel.

Individualized Degree Program (IDP)

The IDP Program is coordinated and housed within COE and provides the programming and updating of records and advising of Micronesian students who are not necessarily able to attend the main campus because of many different financial, political, educational, and familial reasons. This highly individualized program has helped bring about closure for many islanders in obtaining a specialized education degree to address the dire need for teachers on their home island countries. Many students who might not have had the opportunity to enroll at a major institution such as UOG, are now able to finish their degree requirements through this program. The immensity of the task to house, record, maintain, advise, and program the academic activities of these students has become the most challenging activity at COE.

In 1988, work was begun on establishing a sophisticated relational computer database system to meet the expanded needs of the IDP Program. The IDP Manager is now operational and initial data entry on all current IDP students is completed. These records were checked and updated in the summer of 1990. The IDP Manager allows for closer monitoring and tracking of IDP students to insure compliance with the IDP policy as well as facilitates completion of their degree program requirements.

In October of 1989 and in September 1990,COE, the Center for Continuing Education and Outreach Program (CCE-OP) and the Office of Admissions and Records (OA & R) hosted workshops for the Local Education Agencies (LEA) IDP advisors. At these week long workshops, all aspects of the IDP Program were closely examined. The IDP Manager was introduced and training was given on use of the database. Problem areas were identified and new policies and procedures to strengthen the program were developed and agreed upon. In the Fall of 1991, site visits were made by the IDP Coordinator to deliver the updated IDP Manager program and database to those sites owning the program, and provide additional training in the use of the database for program planning, identifying and troubleshooting problems with the IDP Program, and planning, in conjunction with CCE-OP for the next summer's extension program course offerings.

COE Advisor Program

In the Fall of 1990, the decision was made to develop a customized program software to address the current need of the College to standardize student advisement. Advisement was a critical area as extensive problems existed in procedures. No standard format was followed by faculty. The prototype idea for the COE Advisor Program was first introduced by an off-island consultant and piloted with selected faculty. It provided a simple curriculum outline for each of the various different majors that existed in COE. Each program was a list of courses the student needed to take at the College in order to complete degree requirements and graduate. The faculty who used the first prototype commented that it was not a decision making tool, thus, it was deemed inefficient and useless.

As the new COE Advisor Program was conceptualized, faculty input was sought. Every step of the advisement procedure was scrutinized. Cases providing exemptions were analyzed and how the system should approach solving these problems. The final version of the COE Advisor Program now holds a data base system that includes transcript records of currently enrolled students; extensive demographic information of each student, catalog program outlines from 1978-1992 of all COE major programs, flexible reporting procedures, and a built-in system for counts and simple computations. The most beneficial aspect of the Program was that it was able to perform rudimentary decision making tasks.

At the completion of the development of the COE Advisor Program, plans to market the product within the region are already underway. The outreach capabilities have already been realized as standardization has become the most critical aspect for recruitment and maintenance of students within the region. The close monitoring of regional students and the linkage with several sister institutions within the region are seen as vital communication setups for more efficient transfer of student records and other significant information needed to make critical decisions on student life and behavior at the College and University of Guam.

Teacher Education Scholarship Program (TESP)

COE will also house in the immediate future TESP, which is a program being designed and developed to provide data about teacher training scholarships and other financial assistance programs to promising students who are accepted at the junior level into the College of Education. The program will have extensive demographic data on currently enrolled students and including past recipients of the scholarship. A data base system is being developed to generate the various different reports needed for decision making processes at the administrative level.This will include a connection with other data bases within the network system as well. TESP will be an information data base whereby faculty and administrators can retrieve student demographic information to analyze trends and characteristics of majors for recruitment and promotional purposes. Other uses of the data include quantitative and qualitative analyses for research purposes. The final integration of all systems will include advanced reporting such as a five-year projected budget plan and coourse offerings designed around a cyclical pattern.

Network System Problems

As in any development and implementation of a major communication and management information system, COE is not exempted from the various different problems that have become apparent. These problems can be categorized into four major areas: (1) user; (2) software; (3) hardware; and (4) system.

User

It was first difficult to win over several faculty to the idea of advanced computerized technology as a means of achieving efficiency and the management of College data. These faculty were individuals who relied heavily on a traditional mode of communication including the generating of a tremendous amount of paperwork and the reliance on other staff personnel to process the information including typing and clerical tasks. The divisions were very clear as it took time for these individuals to use the equipment and system to incorporate skills never before thought to be a part of their responsibilities.

Another problem that existed within users is the varying degrees of proficiency in use of such technology. Some faculty were more proficient than others in the use of computers. Both staff and faculty personnel received comparable training but still were not as proficient as others and tended to limit their use to automating their own individual task responsibilities.

The most interesting difference among users of the system was the observed rate of learning and its impact on utility. At varying points some personnel learned quickly and made application as appropriate. Others took a gradual course in their learning development as they applied their utility with caution. Users frequently stuck to their unique utility of the system and, depending on what program was mastered or learned, became power users. Once a program was mastered, users ventured out to learn others. Most of COE's personnel wanted to learn other programs that were somewhat related or could interface with the current programs they have mastered. It appeared that learning was a gradual vertical process but later became horizontal once some mastery was achieved.

Software

The problems in software were not within the programs themselves, but were with personnel who had achieved only minimal utility for them. It took awhile for most personnel to realize the high potential use of the software that were already available in the system. For example, the word processing software was mainly used for typing, spelling, and editing purposes. After extensive training, both staff and faculty learned to incorporate simple graphics already available within the program. These included outlining formats, creating tables, and formatting manuscripts. After achieving some level of confidence, faculty and staff started becoming creative in their uses of specific software programs.

Another example is the electronic mail program. Once the basics were learned, most did not venture to create nor explore the vast potential for this software. Eventually, efforts were made to educate all COE personnel to the full potential use of the electronic mail system.

Hardware

The problems associated most with hardware was a breakage in the system network. The vulnerability of the system was quickly realized in the first stages. Loose connections took time to find as the entire length of the network system went far beyond 1200 feet. Locked offices and disconnected computers hampered work needed to solve network problems of hardware.

The only problem experienced in hardware related to the equipment was malfunctioning or frozen keyboards. Because the island experiences high humidity, this affected several computer keyboards. Additionally, the high fluctuation of voltage coming through the outlets necessitated that surge protectors be required of all equipment. Most hardware problems were solved when these were addressed.

System

Problems associated with the system were distance and speed. The length of the system brought about "ghosting" as accessibility to servers and electronic mail was hindered. This problem was solved with the purchase of another systems "router" to provide an extension to the system over a slightly longer distance. And, after the eventual hookup of most users, and the establishment of the data bases within the network servers, it was soon realized that the system became slower due to the lack of memory.

Conclusions

The development and eventual implementation of a data bank management system at the post secondary education level requires a systematic assessment and evaluation approach to those factors that would be most influenced by the change. Significant in these is the personnel who would be tasked to learn the system and to utilize its programs for advancing professional skills while increasing operational efficiency of service delivery to consumers. Even more crucial is the complete understanding of the types of services that are to be provided alongside the policies and regulations that govern them.

While COE has developed DBMS to achieve efficiency in its operations, the benefits of this change are quickly felt as services to the University, local and regional connections to other systems are provided. The changes incurred covers a broad spectrum of impact for faculty, staff, and students through skill development, efficient services, and standardized handling of traditional activities. Moreover, the rewards for its use are inherent in the observed increased collaboration amongst faculty and the overall efficiency of the College in handling a tremendous amount of information on a daily basis. Despite the costs expended, the long term effects of such a system appears to be worth more than what initially was anticipated.

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Appalachian Distance Learning Project

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Abstract

Pressure to change curriculums that provide preservice educators with skills that will allow them to be experts in pedagogy and their subject-matter, design syllabi to meet the needs of below average; average; and above average students, design syllabi and lesson plans geared towards special education students and culturally diverse student populations is increasing.

A collaborative effort between Ohio Bell, Ameritech, G.T.E. North, The Public Utilities Commission of Ohio (PUCO), and Ohio University's College of Education was established to bring about education training reform. Through the use of fiber optics and two-way full-motion video technology, preservice and inservice educators, professors, technicians, and administrators will have an opportunity to provide third grade students at three elementary schools in Southeastern Ohio a multi-interactive distance learning environment.

Preservice education curriculums are being changed to provide preservice educators with skills that will allow them to be experts in pedagogy and their subject-matter, design syllabi to meet the needs of below average; average; and above average students, design syllabi and lesson plans geared towards special education students and culturally diverse student populations. The demand to increase curricula that will allow preservice educators to obtain the aforementioned skills is magnifying. The time has come to challenge the past teaching systems, that some believe were designed to produce mediocrity. For years we have been debating the effectiveness of technology in the classroom. Can computers really free the teacher, so that there may be extra time to work one-on-one with that child who needs special attention to excel. Well, we have discovered that the teacher was not adequately prepared to teach their subject-matter and implement technology (Marcom and Bellew, 1985; Stasz and Shavelson, 1985). There was also the cost factor and the fear of using a machine to teach. The early efforts in designing computer systems that would allow teachers to share software and do so inexpensively worked to a limited degree. However, we are entering a new age of technology whereby teachers can design their own software, without using programming languages. We have entered an age where computers can control various delivery systems that can be used to deliver a multitude of media types for learners with diverse learning styles. With the cost of technology becoming more affordable and with the cooperative efforts of business and universities to work with our schools, we have opened avenues and learning opportunities that were once unaffordable to some school districts. We are looking to establish paradigm shifts that require innovative and creative approaches to teaching.

A collaborative effort between Ohio Bell, Ameritech, G.T.E. North, The Public Utilities Commission of Ohio (PUCO), and Ohio University's College of Education was established to bring about education training reform. Through the use of fiber optics and two-way full motion video technology, preservice and inservice educators, Ohio University faculty, technicians, and administrators will have an opportunity to provide third grade students at three elementary schools in Southeastern Ohio a multi-interactive distance learning environment. This environment will allow all parties concerned to improve their pedagogical skills, and learn to use technology as an enhancement tool within existing curriculums. Throughout the United States school districts, and entire states, are experimenting with distance learning (e.g. Arizona, California, Iowa, Mississippi, and New Mexico) as a means of delivering courses to rural or financially disadvantaged schools or school districts. The Appalachian Distance Learning Project is attempting to challenge the limits of technology by developing a multi-interactive environment. Professionals and students will have an opportunity to communicate via the two-way full-motion video technology. The second level of interaction occurs when students from one school district is able to manipulate software at another site.

Project Design

The Appalachian Distance Learning Project was designed to allow several cameras to be located, unobtrusively, in each classroom, including a dedicated classroom at Ohio University. Each third grade classroom will have up to ten professionals working cooperatively and communicating interactively, via headsets, to provide third grade students an opportunity to work individually, in small groups, in large groups and/or interactively via the technology. The ten professionals consists of a technician, faculty member from Ohio University, master teacher, four student teachers, and three practicum students. Eventually, the technician will be replaced by the master teacher or faculty member (leaving nine professionals). Some of the professionals will have responsibilities that require them to work as system managers. On an assigned day a student teacher may review courseware, provide suggestions to the graduate students who are developing curriculum materials, copy and collate appropriate documents, as well as escort third graders to the rest room.

The Ohio University site will serve as a evaluative, demonstrative, and viewing site. Faculty members who have an expertise in teacher training and relevant content will offer participating professionals advice and suggestions, as well as demonstrate hands-on activities to the three elementary school sites. Preservice and inservice teachers will be allowed to come in and view these classrooms while they are working interactively. Graduate students with an emphasis in media and technology related disciplines will design software (including CD-ROM and laserdiscs) that support curriculum materials that are to be used in the project.

Management

Managing the Appalachian Distance Learning Project will be the key to the success of the project. Coordinating the schedules of approximately 30 individuals at four different sites will not be an easy task. Also, since there are three different curriculums we must be sure not to restrict any master teacher and allow them to continue to meet the district's content requirements for third grade students. In selecting the participating schools we received a commitment from the Superintendents and the building Principals that they would allow for flexibility within their respective curriculums.

Concerns

In setting out to try something that is new there are a myriad of questions that had to be answered and could serve to assist others in designing and implementing viable distance learning projects. We were not able to answer every question, however, we were able to discuss possible solutions, some that are currently being implemented Here are a sample set of questions from our conversations with all parties involved in the distance learning project.

Q. Will we be able to integrate our current computer systems with the new technology in the dedicated third grade classroom?

A. There is a possibility that your current computer systems will be able to link up with the fiber optic network. Each designated third grade classroom will have new hardware and software, some developed by Ohio University Graduate Students to enhance curriculum materials.

Q. Will this fiber optic network system eventually be used by other schools in the school district?

A. We are hopeful that before the conclusion of the project that opportunities will arise that will allow us to expand the project to other schools in your district as well as the state.

Q. Will we be able to send data to the school district office and /or the State Board of Education?

A. There exists the possibility to access remote databases that could be used instructionally and administratively.

Q. Since the program is funded for three to five years, what happens at the end of the fifth year?

A. Again, we are hopeful that the project will spread to other schools and school districts. We shall continue our partnership with the schools and school districts involved as well as work cooperatively to establish/ maintain technology based learning environments.

Q. How long will a student teacher be assigned to a particular site?

A. We are asking student teachers for a one year commitment to the project which would allow them adequate time to become familiar with academia, in general, and teaching in an elementary school, specifically.

Q. How long will practicum students be involved in the project?

A. Practicum students will continue in the project for one quarter (10 weeks).

Q. How can parents get involved in the project?

A. Parents will be invited to the designated third grade classroom and observe how the technology will work as well as review the materials to be used in the classroom (e.g. CD-ROM, laserdiscs). There is also the possibility that some evening adult classes may be sponsored by the local school districts or corporations in a particular school district.

Q. How will professionals involved in the project be compensated for the extra time that they must put into the project?

A. There are some monies available for staff edification that will be dispensed according to a determined scale.

Q. Where will the training sessions take place?

A. The training sessions regarding the classroom hardware and collaborative efforts to devise a viable third grade curriculum will take place on Ohio University's main campus (Athens). The training regarding the video equipment will take place at each elementary school.

Q. What happens when the third grade student moves to the fourth grade?

A. The third grade students will return to their school's regular curriculum once they move on to the fourth grade. However, there might be the possibility of opening the classrooms up for student-to-student interaction following their first year maintaining friendships and collaborative efforts between interested professionals.

Q. Will it be possible for the third graders to visit the other participating schools?

A. Yes

Q. With nine professionals in a classroom at a given time who does my child ask to go to the rest room?

A. There shall be designated individuals to deal with special circumstances such as restroom usage, emergencies, etc.

Q. How much interactivity will be involved in this distance learning project?

A. We are optimistic that we will have two levels of interactivity. The first level occurs through the connectivity of two-way full-motion video technology and correspondence. The second level occurs when a student from School B can manipulate the software (or courseware) located at School A or School C.

Conclusion

We are exploring, and challenging, technology to bring about cooperative, efficient, and quality oriented learning environments. Teachers will have opportunities to develop and implement innovative teaching methodologies. Ohio University faculty will have an opportunity to work directly with teachers and examine, first hand, the strengths and weaknesses associated with a multi-interactive environment. Third grade students will have an opportunity to build their self-confidence, improve their communication skills, and increase retention rates through finding and using information. Student teachers and practicum students will have the opportunity to work with state-of-the-art hardware, participate in the development of technology based curriculum materials, learn the positives and pitfalls of an multi-interactive environment, and learn how elementary school children adapted to such a technology based environment. We are optimistic that when the preservice and inservice professionals work is completed in this multi-interacitve learning environment they would have developed additional teaching methodologies that would assist them in designing syllabi that would meet the needs of diverse student populations.

Acknowledgements

I would like to thank Dean H. Wells Singleton for sharing his insight into the direction of the project as well as his vision of cooperative teacher reform.

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Multiple Site Inservice Teacher Education: Via Interactive Television

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Abstract

This paper describes the use of two-way interactive television (ITV) in the program leading to the Master of Education in Teacher Leadership offered at the University of Minnesota, Twin Cities.

The Master of Education in Teacher Leadership program objectives are:

1. to develop advanced skills in specific curricular areas related to current and future teaching assignments
2. to provide an understanding of current reform and policy issues facing education
3. to develop leadership skills that are particularly relevant for classroom teachers who participate in development work in their school.

The University of Minnesota is providing instruction via interactive television (ITV). Disadvantages associated with the ITV process include: difficulty in recognition of students, audio feedback from microphones, classroom noise levels, broken or malfunctioning equipment and down time with the ITV network.

Institutional benefits include increased market share and lowered demand for classrooms and positive relationships with other educational agencies. Students experience fewer problems associated with on campus classes including: ease of registration, short commuting distance and greater accessibility to parking. Instructors, using the ITV team teaching approach, broaden their teaching repertoire, making use of available multimedia technology and developing a multi-perspective approach to teaching. For these reasons using ITV is an appropriate, effective and desirable method of inservice teacher education

Introduction

This paper describes the use of two-way interactive television (ITV) in the program leading to the Master of Education in Teacher Leadership offered at the University of Minnesota, Twin Cities. Included is a brief description of the program and course offerings. Following is a listing of the equipment process and classroom design used in the ITV. Next is a discussion of problems and advantages in using ITV. Included are recommendations for facilitating the use of ITV in teacher education.

Master of Education in Teacher Leadership

The University of Minnesota Twin Cities, through a joint effort by the College of Education and the Continuing Education and Extension Division, established a M.Ed. in Teacher Leadership. The program was developed by two units within the College of Education, specifically the Department of Curriculum and Instruction and the Department of Education Policy and Administration.

The Master of Education in Teacher Leadership program objectives are:

1. to develop advanced skills in specific curricular areas related to current and future teaching assignments
2. to provide an understanding of current reform and policy issues facing education
3. to develop leadership skills that are particularly relevant for classroom teachers who participate in development work in their school.

Course Offering

The course used as the basis of this paper is Shared Decision Making and Group Process. This new course is designed to assist educators in becoming effective participants in the decision making process. The course focuses on opportunities for decision making that have developed as a result of educational change, including: site based management and out-come based education. Topics covered include effective group process, decision making, multi-constituent group behavior, learning styles and effective leadership. All of which have application in schools.

Because this was the first attempt at using ITV for the instructors involved, as well as the first offering of a new course and a new program, it was decided the course would be team taught by two senior faculty members with the assistance of a graduate student. Each member of the team rotated among each of the three sites to ensure that each site had an instructor present.

The University of Minnesota chose to offer the class at three sites using the two-way ITV fiber optic network. The ITV classrooms are located in two high-school district buildings and one intermediate school building. The greatest distance between the furthermost two buildings is 50 miles.

Classroom Equipment

Each classroom has three cameras. One focuses on the instructor, another on the students, and a third on visual materials. The instructor selects the signal to be sent from a switcher located on the control center, adjacent to the instructor's desk. Students observe their site plus the others from three color monitors located in the front of the class. Teacher remote site monitors are located in the rear of the class. The instructor monitors the signal being sent from the home site via a nine inch black and white monitor on the desk.

Verbal interaction among the sites is accomplished with microphones. There is a microphone on each student desk. Instructor's microphones attach to either a lapel or collar. All microphones are controlled from a sound mixer located at the teaching center and are live at all times unless turned off at the mixer.

Each classroom has a FAX machine for transmission among the sites. In this case the FAX machine also serves as a vital phone link among the sites. Also located at the control center is a VCR which may broadcast to all sites. However, the VCR can only record the signal being sent from the home site rather than the signals from all the sites. Computer hook-ups are also available delivering computer images to the sites.

Discussion

Orientation and Preparation

It is no small undertaking to attempt to teach a shared decision making /group process course on ITV. The subject matter demands extensive work in groups and debriefing sessions. Some believe it is ineffective to teach this course using ITV, because of a perceived communication limitation among the sites.

One way to overcome these perceived limitations is an initial orientation session for instructors and students to familiarize them with the ITV process. It is more important for instructors since they control the equipment. A moderate level of proficiency can be gained in a relatively short training session. If anything such a training session decreases the apprehension an instructor feels when using new technology. Students will appreciate the instructor's position in using the technology in addition to being an excellent opportunity for the students to become acquainted with ITV. Therefore, an initial orientation session is strongly recommended.

There are many ways to prepare for class. However, when using ITV and team teaching thorough preparation is essential. One of the best ways is to write a script. Scripts may take many forms from a word for word copy of what will be said, to a general outline of material to be covered. The most essential aspect of a script is time allocation. The ITV process seems to require more time to complete a task than the traditional classroom. This is especially true in the group work and discussion sections. It takes longer to gain the site's attention following an exercise and to distribute and collect written materials. As a result it is recommended that a generous block of time be allocated for each task.

Problems

As with any innovation there are problems. First, it is difficult for instructors to learn the students names and faces as quickly as they would like to do so. This is especially true for large ITV classrooms or for those students who sit towards the back. To combat this problem large name plates, clearly readable from 25 feet, were constructed. Facial recognition continues to be a problem. A solution is to purchase a wide angle higher magnification camera lens or, if possible, move the students closer to the camera.

Second, sound feedback, especially from the remote site's instructor's microphones, is a problem. This was solved by turning the volume to zero when not in use. A related problem is the noise level during the class. Students forget their microphones are voice activated. Consequently, when students chat during class it is received by all sites, thus increasing the classroom noise level. A reminder to students from time to time alleviates this problem.

Third, are times the ITV system will be down. This is frustrating to students and instructors especially if the course is content oriented. It is encouraged to have a technician check each site at least two hours before class to ensure the system is working. This allows enough time to notify students to convene at an alternate site if possible or to cancel class. Other technical problems experienced were broken speaker wires, inconsistent volume levels among the sites and monitors and FAX machines not functioning. For these reasons it is helpful to have an on site technician to handle any minor mechanical problems.

Advantages

The benefits of ITV far outweigh the problems. First, the institution gains a larger share of the education market by providing classes for people who do not wish to attend classes on campus. The possibility exists in the future to reach teachers in isolated areas for whom there are no educational opportunities currently available. Secondly, the demand for on campus classroom space is decreased. Lastly, ITV builds a spirit of cooperation between the University of Minnesota and local high-schools.

Students also benefit from courses offered through ITV. Many teachers enrolled in the program can remain in their work building to take classes. For others, sites are located close to their homes reducing commuting time, parking difficulties and long walking distances usually associated with large urban universities. Registration is easier because students can register by mail, or on the first night of class. Representatives of the Continuing Education and Extension Division bring textbooks for the students to purchase on the first night of class; eliminating the need to go to a campus bookstore to purchase course materials. Interactive television allows students to network with other teachers at the different sites. Finally, ITV provides students with an excellent modeling for using technology as part of the teaching process.

Instructors benefit from the ITV process. First, the team teaching approach requires instructors to meet regularly to plan and discuss class content and process. All instructors are able to incorporate their individual perspectives providing students with a multi-perspective orientation to the subject matter. Second, team teaching exposes more instructors to ITV which increases the number of individuals with ITV experience to teach class in the future. Third, the ITV equipment increased the diversity of multimedia used throughout the course. Finally, inherent in ITV are methodological and pedagogical challenges which must be overcome; such as developing ways to use the technology to address a content area that would ordinarily best occur in the traditional classroom.

Conclusion

The University of Minnesota is providing instruction via ITV for courses taken through the Master of Education in Teacher Leadership Program. Disadvantages associated with the ITV process include: difficulty in recognition of students, audio feedback from microphones, classroom noise levels, broken or malfunctioning equipment and down time with the ITV network. However, the benefits far outweigh the problems. Institutional benefits include increased market share and lowered demand for classrooms and positive relationships with other educational agencies. Students experience fewer problems associated with on campus classes including: ease of registration, short commuting distance and greater accessibility to parking. Instructors, using the ITV team teaching approach, broaden their teaching repertoire, making use of available multimedia technology and developing a multi-perspective approach to teaching. For these reasons using ITV is an appropriate, effective and desirable method of inservice teacher education.

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Considerations for the Design of Distance Education Classrooms

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Abstract

Major advances are occurring in the area of hardware for sophisticated delivery of distance education. Too often, critical considerations of classroom design are not addressed until after implementation of the distance learning program. Once a distance delivery system has been selected, the success of the program may well hinge on a classroom design that is functional and practical for the instructor and sensitive to the multi-sensory capacities of the learner. This paper discusses construction considerations, classroom dimensions, interior design guidelines, acoustics guidelines, and lighting guidelines. It is through careful consideration of the interaction between these design variables that distance education will be most effective and successful.

In order to make the most effective use of a distance education delivery system, classroom design should be a primary consideration. Technical aspects of contemporary telecommunication technologies present special challenges. A properly designed classroom will enhance content objectives and increase acceptance of this type of instructional delivery within student and faculty user groups (Price, 1991).

This paper will describe key considerations for optimal design within five areas: construction considerations, classroom dimensions, interior design guidelines, acoustics guidelines, and lighting guidelines. Considerations of cost must be included in the actual design process, but are not addressed in this paper.

Construction Considerations

Whether the classroom is to be a ground-up construction project or is to be a re-model of an existing classroom, the following considerations are important. While it may not be possible to meet the optimal standard in every consideration, remember that these are inter-related criteria and poor application in one area may well be reflected elsewhere.

The hardware system cable structures are sensitive to electro-magnetic fields, heat, vibrations, surges, and spikes. Thus, the classroom wiring system should not be located near compressor motors, blower motors, elevator motors, heating, ventilating or air conditioning systems/wiring structures (Cogliano, 1991).

For maximum effectiveness and minimal system failure, consider inner liners or separate conduit for each connection. Protect electrical services by installing surge/spike protectors. The best option is to service these classrooms through a set of dedicated circuits with the breaker panel installed in the classroom and clearly labeled as to the control function of each breaker. Provide for future increases in the need for electrical service by including additional capacity in the breaker panel

(Allen, R.L., 1991).

When complete, these classrooms will have complex networks of wiring that may or may not be connected to permanently fixed structures. Maximum flexibility in use is permitted with the installation of a wooden sub-floor that allows access to floor wiring structures for up-date or repair purposes. Sub-flooring also allows for the installation of outlets on the floor as well as on the walls. Access to ceiling wiring should be through suspended ceilings. Electrical service is a complicated problem that requires careful forethought and competent installation.

All of the equipment associated with the delivery of distance education generates heat. While it is necessary to have an HVAC (heating, ventilating, air conditioning) system in support of this equipment, the circulation of air should not be achieved at the expense of controlling a) the background noise of the HVAC system or b) the effective usage of the delivery system. Options to consider are diffusers and acoustically lined duct-work.

Each classroom should have a temperature-sensitive monitoring device within it. Temperature should be maintained near 70 degrees and humidity at 40 to 60 percent (Allen, R.L., 1991).

Telephone wiring should be included and should consider future provisions for increased voice, data and video transmissions. Multiple phone jacks should be accessible in various classroom locations.

To improve acoustic weaknesses, choose locations in a quiet area of the building (Carl & Densmore, 1988). Best effort should be made to stay away from restrooms, vending machines, lobbies, plaza areas and elevators. Doors should be of solid construction and equipped with weather stripping and floor sweeps (Price, 1991). Doors should be situated to be outside camera view range; usually at the back of the classroom. Windows should be avoided, if possible. Finally, these classrooms are major investments and represent complex instructional environments that may require specialized security arrangements.

Classroom Dimensions

Most distance ed classrooms are designed for 12 to 20 students, but these dimensions may be altered to adapt to larger student groups if the hardware specifications are manageable. Generally, the classroom length should be one and one-half times the width. Rectangular shapes are more conducive to viewing angles and acoustics than are square shapes. Allow approximately 30 square feet per learner (Carl & Densmore, 1988). Recommended ceiling height is 12 feet (Allen, M., 1991).

Classroom configuration needs to consider the content to be offered, the prevalent instructional style, the number of learners, and the hardware that is to be used. Regarding monitor selection, a general rule of thumb is one viewer per diagonal inch of monitor; e.g. a 20-inch monitor can serve at most 20 viewers. The maximum viewing distance is usually twelve times the monitor screen width. The minimal viewing distance is between four and seven feet (Price, 1991). Ideally, learners should be allowed to find their personal preferred viewing location. Monitors should be mounted so that the viewer angle is no more than 30 degrees. Monitors should not be placed in corners. Not only does corner-mounting create awkward viewing angles, it also diminishes the importance of the visual presentation. Particular attention should be paid to the safety issues involved with mounting monitors on walls or overhead.

Interior Design Guidelines

Research in distance education indicates that appropriate aesthetic and functional qualities of the classroom contribute to favorable learner attitudes (Price, 1991). Distance education classrooms are particularly susceptible to poor audio and video aspects of instruction (Cogliano, 1991).

If the classroom design includes windows, they should be covered with drapes equipped with cord tighteners. The drapes offer some control over light and acoustic problems. The window coverings and walls should be mid-spectrum colors, e.g. tans, light blues or grays, to allow easy justification of the CODEC (Carl & Densmore, 1988; Price, 1991; Cogliano, 1991). The color "Jennifer Blue" has been found to be particularly effective (Cogliano, 1991). Trim colors should be light to medium tones. The color white and obvious patterns should be avoided. Non-glare surface finishes are a necessity due to concerns for reducing glare and reflection onto monitor screens. Shiny plastics, glass and chrome finishes should be avoided. Reflectance values for paint can be found in samples and selection charts (Allen, R.L., 1991). If severe audio difficulties are anticipated, consider cloth walls or adding sound soak to existing walls (Allen, M., 1991).

Maximum audio application is facilitated by carpeting floors. Floors should be smooth and free of wiring and cords. Floor color should be light to medium and should contain some type of subdued pattern or fleck. Ceilings should be light colored and made of non-reflective materials.

To account for the differences in learner expectation in a telecommunications classroom, special consideration should be given to individual comfort. Attention should be paid to adequate work space and comfortable seating. At a minimum, learners require a 20-inch deep surface area at which to work (Price, 1991). Individual, cushioned, moveable chairs provide a major, positive, critical attribute of optimal distance education classrooms. Upholstery should meet previous color guidelines, be non-reflective, and, hopefully, be aesthetically pleasing.

Each classroom should provide an adequate and secure storage area for peripheral instructional equipment, as well as materials needed on a repeated basis (Allen, R.L., 1991).

The instructor area should be designed to accommodate the hardware controls that the instructor will need to access within the lectern. Consider designing the instructor area as a slightly raised area complete with proper lighting and acoustics. Easy access to remote control devices, switching mechanisms and the electric tablet are essential. An adjustable, cushioned stool should be available. The instructor should be able to view all off-site monitors on the same line of sight that the instructor camera is set on. Blackboards and whiteboards do not emit quality video transfer, and should not be included in 2-way telecommunications classrooms.

These classrooms are not particularly conducive to individualized student/teacher contact. For this reason, it is recommended that a corner of the classroom be partitioned off to create a small, private conference area that will allow the instructor the ability to have a private conference with a remote site student. This area needs to be equipped with a camera, small monitor, and microphone whose transmission is separate from the classroom transmission hardware.

Acoustics Guidelines

The greatest obstacle to optimal distance education classroom design is audio difficulties. Instructors and learners alike, most often report that the sound quality is the component that least meets expectations. The goals of optimal acoustic design are to limit interior and exterior noise, and to control echoes (Price, 1991). Some mention has been given regarding these goals in previous sections of this paper, but there are additional considerations.

Plaster walls, tile floors and tile ceilings create constant echo (Cogliano, 1991). Walls and floors should be sound resistant and constructed of dense material. Walls should extend above suspended ceilings to the roof or floor structure above (Price, 1991). Acoustical quality will be improved with non-parallel walls. Ceilings should be suspended and made of acoustical tiles. Contemporary CODECs generally include an automatic adjustment for acoustics, but it is not advisable to rely on this technology alone. Similarly, various electronic echo-suppressing systems are available, but they have received mixed effectiveness ratings. Echo-cancelling systems are effective for dealing with acoustics concerns and should be included. Tabletop microphones, suspended PZM microphones or angled shotgun microphones are recommended for the learners and a wireless lavaliere microphone for the instructor. Microphone feedback and coverage area are key considerations in this decision. Attention to these details as well as the quoted hardware specifications compound the probability of quality audio transmission.

Lighting Guidelines

Control of lighting is an important consideration within telecommunications classrooms. Good lighting designs allow fixtures to be selectively switched off or dimmed. Halogen lamps are good light sources, but more expensive than a combination of fluorescent and incandescent fixtures. This type of lighting combination allows a more pleasing balance of color and reduces flicker phenomena on monitor screens. Provisions should be made for a highly concentrated light source at the instructor lectern. Avoid unshielded light surfaces and natural light. Overhead lighting is best for students; horizontal lighting is best for cameras (Hudspeth & Brey, 1986). Indirect student lighting can be accomplished using fixtures that reflect the light source back to the ceiling instead of down upon the student work areas. An alternative is to install diffusers or baffles (usually at 45 degrees) on the existing fixtures (Cogliano, 1991). Cool white lights enhance visual comfort; recommended levels are 30 to 100 footcandles. Light levels at the remote sites need only be high enough to provide a good out-going camera image. Over lighting at remote sites is common.

Conclusion

By now it should be obvious that the complexity of the variables within the physical environment of a telecommunications classroom requires tremendous planning and attention to the inter-related characteristics of these variables if the design is to meet the needs of the learner in a non-traditional classroom setting.

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Organization of Successful Teacher Education Activities on Electronic Networks

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Abstract

The present study critically analyzed successful network activities conducted on a school-based grassroots distributed electronic network to find out what makes educational network activities successful. Electronic mail messages exchanged on the network, diaries of network usage, and telephone interviews with key participants of the network activities were analyzed for each project to determine its design, organization, and implementation. Network activities were successful in facilitating the teaching of knowledge and skills at elementary, secondary, and college levels and from several important curricula areas. Recommendations are made for promoting policies for teacher education applications of electronic networks including a teaching teleapprenticeship model for in-service and pre-service education. Recommendations are also made for integrating network activities into classrooms that are sensitive to activity stages, distributed communities, and network audiences.

Introduction

Education in the Information Age

Major components of society such as business, government, communication, transportation, entertainment, science, and medicine have adapted to meet the shift from the Machine Age to the Information Age. The organization of education including the preparation of teachers and training of students has changed very little since the advent of the Machine Age. Formal and informal teaching and learning activities have been carried out in a similar manner since the seventeenth and eighteenth centuries. Today education is conducted in a manner as if the machine age was flourishing where students are required to develop survival skills needed in a rigid industrial society with a worldview dominated by machine-based philosophy, values, culture, and practices.

In the Information Age time and space take on different meanings and new concepts such as a global economy must be understood for nations, governments, business, schools, and students to compete and survive. Major research reports such as *A Nation at Risk* suggest that there is a need to restructure education to meet the challenges of the Information Age. An electronic network is an application of computers that has been used successfully by big businesses and governments to survive and adapt in an information society. In the field of education, networks allow for new models of education that exploit the strengths of information and communication technology to prepare and promote meaningful lifelong learning for students and teachers beyond the physical limitations of classrooms and traditional concept of schools.

Problems of Network Supported Education

There are problems associated with using networks to restructure the way teachers are prepared to teach and students are educated to become productive and functional citizens in a global-economic information world. We still know little about how successful network activities are designed, organized and implemented by college instructors, graduate students, and classroom teachers in formal and informal classroom, teacher training, and continuing education contexts (Newman & Tors, 1990).

Purpose

The purpose of the study reported here was to determine the factors leading to the success of educational activities conducted on distributed electronic networks created and implemented by teachers and students.

Method

A number of educational activities conducted on a nationally and internationally linked network used by thousands of teachers and students were selected as successful and critically analyzed to address research questions. Several methods were used to select successful network activities and to collect and analyze data on those activities.

Sample

Nine hundred and twenty two activity proposals posted on an electronic bulletin board on a grassroots school-based electronic network between January 1989 and June 1990 were examined. Forty three were selected by using researcher designed criteria and participant self-evaluations. Sixteen of those activities were judged as successful by editors of a mediated electronic bulletin board on the network designed for publishing electronic reports of successful network activities and these were selected for intensive study.

Data Collection

The data for this study consisted of electronic mail messages exchanged on the network as well as diaries of network usage and telephone interviews with key participants of the sixteen successful activities.

Data Analysis

Each network activity was described along several dimensions including organization of the activity, implementation of the activity, problems of the activity, recommendations for improving the activity, and sequence of network stages. Network messages were classified into the following network stages:
(a) proposal,
(b) refinement,
(c) organization,
(d) pursuit,
(e) wrap-up, and
(f) publication.

The frequency of messages exchanged for each network stage was tabulated and the sequence of network stages was graphed for activities.

Results/Discussion

Network Activity Stages

Earlier work report that network activities can be described according to readily identifiable stages through which they progress during an activity cycle: proposal, refinement, organization, pursuit, wrap-up, and publication (Levin, Waugh, Chung, & Miyake 1991). Analysis of the sixteen successful activities show that network stages proposed by Levin, Waugh, Chung, & Miyake (1991) exist and that two patterns were present that described the progression of successful network activity stages: (a) Simple Structured Network Activities, (b) Complex Structured Network Activities (Stapleton, 1991; Stapleton, Levin, & Waugh, 1991).

Simple Structured Network Activities

The first pattern (Figure 1) which represents the Simple Structured Network Activities Model shows that many successful network activities start at the proposal stage and progress fairly smoothly to the wrap-up and publication stages where the activity comes to the end of its life cycle. This is characteristic of activities that require few responses or tasks from interested network participants who are asked to respond to a prompt such as a questionnaire, survey, or topic for writing or drawing exchanges. These activities require minimal refinement and organization of the proposed ideas, materials, and resources and minimal management and coordination of participants and activity tasks. The Weather Holidays project which involved participants responding to a classroom teacher's request for network activity participants to describe weather related conditions that caused schools to shut down is an example of a Simple Structured Network Activity.

Complex Structured Network Activities

The second pattern (Figure 2) which represents the Complex Structured Network Activities Model shows that many successful network activities start at the proposal stage, fluctuate between the refinement, organization, and pursuit stages as the activity progresses, and stabilize when they get to the wrap-up or publication stage. This is characteristic of activities that require a semester or more to implement and are complex in their design and implementation. The Noon Observation Project which involved participants replicating an ancient scientific experiment by measuring the shadow of the sun at local

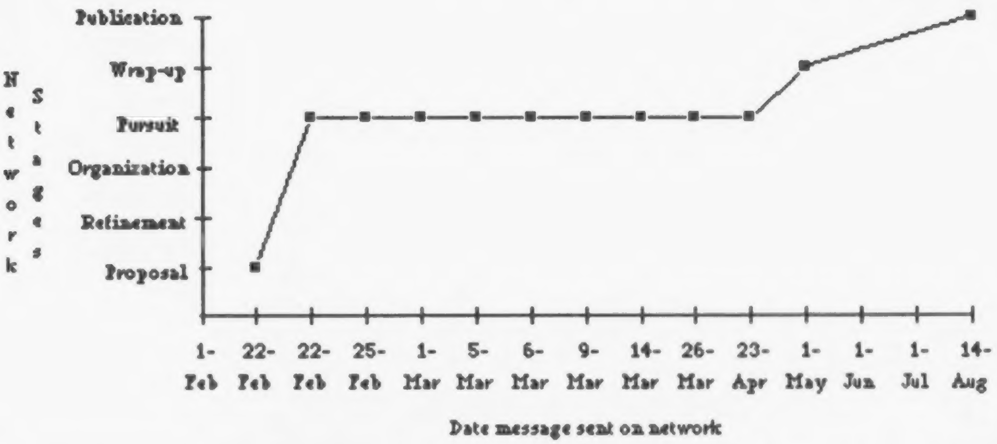

Figure 1. Sequence of stages for messages exchanged during the Weather Holidays Project.

noon at distributed sites where real data was used to jointly calculate the circumference of the earth is an example of a Complex Structured Network Activity.

The distinguishing factor of the complex and simple models of network activity message flow and stage progression is that complex activities involve more shaping, coordination, and management while simple activities require relatively less (See Table 1). This is supported by the absence of messages exchanged during the refinement and organization stages for the Weather Holidays activity while the Noon Observation activity had a majority of messages during those stages.

Table 1
Number of Messages Exchanged for Successful Network Activities by Stages

Teleapprenticeship Models of Education

Activities such as the Noon Observation and Weather Holiday can serve as a source of successful educational network activity ideas for supporting teleapprenticeship models of education. We have described several types of teleapprenticeships (Levin, 1990; Levin, Riel, Miyake, & Cohen, 1987; Levin, Rogers, Waugh, & Smith, 1989; Levin, Waugh, Glidden, & Travers, 1989). Two teleapprenticeship models are: science teleapprenticeships and teaching teleapprenticeships.

Science Teleapprenticeships

In science teleapprenticeships groups of scientists who use networks are identified and classroom teachers and college professors mediate learning activities and tasks involving classroom students and scientists. These activities allow students to understand the work scientist do as well as the scientific process (Waugh & Levin, 1989). These experiences allow students to gradually participate in meaningful activities beyond the walls of the classroom dealing with real problems faced by practicing scientists and are progressively given opportunities to manipulate real data to assist in solving real problems (Levin, 1990).

Teaching Teleapprenticeships

Teaching teleapprenticeships involve teachers at college programs who use networks to engage in activities between pre-service teachers and classroom teachers and integrate real problems faced by real teachers and students in real classrooms into undergraduate education courses. This allows students to experience real problems facing teachers and students and to discover real solutions before taking their first teaching job (Levin, 1990). By continuing to use the network in their own classroom instructional activities upon completion of the teacher preparation program they will serve as important players in bringing education into the Information Age.

Access, Network Knowledge, Technical Support, and Training

Analysis of the successful activities show that access opportunities, technical support, and knowledge and skills training were provided in pre-service and in-service settings by system operators, instructors, computer resource personnel, graduate students, and classroom students and teachers on the network and at distributed sites during formal and informal contacts with participants (Stapleton, 1991). Following is a message sent by a graduate student to an instructor communicating progress report on an ongoing network activity.

To: [University Professor]
Subj: telecommunications partner?
From: [Graduate Student]

[University Professor],

Thanks again for you help with the problem last week. I will be using the simulation disks Thursday at Danville, Illinois. I sent [Teacher] a note & invited her to join the Most Livable Places for Kids project.

[Graduate Student]

Network Supported Mediation

Analysis of activities revealed the existence of mediation between experts and novices (Stapleton, 1991). In a number of cases successful activities were created and implemented by students and classroom teachers enrolled in extramural classes at a local university. Instructors used the network to communicate with students by giving assignments, answering questions, and advising students on a variety of problems.

Following is a message sent to give students important background information as well as ideas for carrying out an assignment that required students (classroom teachers and graduate students) to design and implement an educational network activity in their classroom with their students. The instructor gave non-examples and examples of successful network activities to provide students with a general conceptual framework for the design and structuring of successful network activities. This was done by outlining several successful and unsuccessful approaches to designing network activities.

To: $SATEX (Saturday-ExtraMural-Class)
From: [University Professor]
Subj: hints on projects

Here are some hints on how to structure your network projects. I'll try to describe some successful "trajectories", paths that folks in this class have taken in past years, and contrast them with unsuccessful trajectories.

Successful trajectories:

1. The "one shot, one hit" strategy: Put out one idea on IDEAS, get a few responses, respond to them, form a conference group, conduct the project, write it up.
2. The "join an existing project" strategy: Find a interesting idea, and join in, carry out the activity, and write it up.
3. The "join and later initiate" strategy:
4. The "multiple shots, one or two hits" strategy: put out several ideas on IDEAS all at once, and conduct the one or two that get the most response.

Unsuccessful trajectories:

1. The "one shot, one miss" strategy: Put out one IDEA, wait and get no response.
2. The "If at first you don't succeed" strategy: Put out one IDEA, wait and get no response, put out another IDEA, wait and get no response, ...

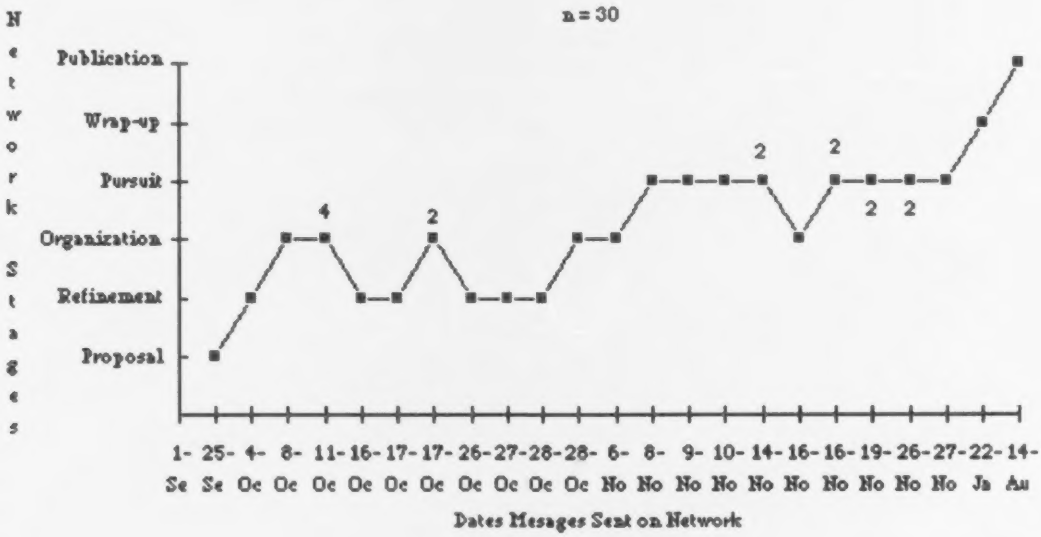

Figure 2. Sequence of stages for messages exchanged during the Noon Observation Project 1990.

There are also several tactics that can help you conduct a successful project.

1. Recruit participants: send out Email messages to individuals inviting them to participate. Watch the IDEAS, and send messages to anyone requesting "pen-pals", focusing the pen-pal exchange in the direction of your project. Offer to reciprocate with fellow $NORTHBROOK class members or with the $SATEX class members, that you'll participate in their project if they'll participate in yours.
2. Send out a sequence of messages. Make your first message short and attractive. Then send out a longer description to those that respond.
3. Don't make your proposal too narrowly focused. These networks support more diversity in the range of folks that participate than is normal for face-to-face projects.
4. Be flexible and willing to reshape your project depending on circumstances.
5. Send out progress reports. This implicitly requests action on the part of the others in your project. For example, the progress report that [Instructor 1] and [Instructor 2] sent yesterday implicitly was intended to remind you to send in your progress reports.
6. Make your messages stand out. Pick an interesting subject header that fits (22 characters or less). Carefully edit your first message so that it catches the eye of potential participants - remember, they'll be scanning through a long list of other IDEAS. [University Professor]

Recommendations

Research findings suggest the following recommendations for organizing successful teacher education network activities. Comprehensive programs for helping both preservice and practicing teachers to exploit the power of networks for teaching and learning activities should consider:

- access opportunities, training, and time for teachers to participate in network activities,
- advanced planning and ongoing communication between educators, administrators, and others,
- meaningful incentives for teachers and students to participate in network activities,
- network support and mediation from network experts,
- a sequence of successful network experiences from simple activities to complex activities.

Teacher education programs should develop long range plans for integrating networking activities as an important method for achieving curriculum goals. Steps should be taken to develop and implement policy and practice that support the above recommendations.

Acknowledgements

This study and major findings stated in this article are based upon a Ph.D. Doctoral Dissertation by Clinton E. Stapleton entitled Analysis of Successful Educational Activities on a Distributed Electronic Network. This material is based in part upon work supported by the National Science Foundation under Grant No. TPE-8953392.

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Planning for the Use of Computer Conferencing in Collaborative Learning

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Abstract

Computer conferencing offers new possibilities for purposeful group learning among geographically dispersed individuals. This paper reviews the significant features of collaborative learning and the research on computer-mediated communications, elucidating a set of planning considerations for use of this technology in this instructional context.

The use of computer conferencing in collaborative learning involves a complex interplay of three sets of conditions: the basic elements of a planned collaborative learning experience; computer conferencing system characteristics; and individual and group characteristics with respect to computer-mediated systems. Planning for such complex interactions among the numerous variables requires an encompassing approach to the multifaceted phenomenon that occurs when a group of individuals, embarking on a collective task, mediate their communication through a computer conferencing system.

This paper will elucidate each of the three sets of conditions which, together, comprise the computer-mediated collaborative learning experience, and suggest planning considerations to guide the implementation of a particular experience.

Elements of Collaborative Learning

Collaborative learning has occurred as long as groups have attempted to work together toward a common goal. It has been during the the last twenty years, however, that collaborative learning as an intentional teaching and learning strategy has seen increasingly formal development, study and evaluation. Pioneered in the elementary and secondary education environments, the technique has found its way into college, university, and corporate settings in undergraduate, graduate, and continuing education applications. The technique, as described by its leading proponents and practitioners is characterized by five basic elements: positive interdependence, face-to-face interaction, individual accountability, interpersonal and small group skills, and group processing (Budin, 1991; Harasim, 1987; Johnson, D. and Johnson, R., 1975; Johnson, D. and Johnson, R., 1984; Johnson, D. and Johnson, R., 1986; Slavin, 1985).

Positive Interdependence

Fostering a positive interdependence among group participants has been found to be a key element in a successful collaborative learning experience. Group members need to feel that they need each other to accomplish the task at hand. This can be done through establishing goals mutually conceived, negotiated, and agreed upon by the group. Establishing joint rewards to be received by all members is another aspect helping to create an environment of positive interdependence.

Shared information and materials are equally important to the group in so far as this provides a basis for members to have insight into the overall task and to be of assistance to each other. The final aspect contributing to positive interdependence is the assignment of individual roles. Each person must understand the part they play and their relationship to the whole project. The presence of these aspects are important to insuring a successful collaborative learning experience.

Face-to-face Communication

As traditionally conceived, collaborative learning involves face-to-face communication. Verbal interactions taking place among students and leaders of the experience are important. Similar to the conduct of effective discussions, periodic synthesizing and summarizing are necessary, as are explanation and elaboration. This is the element of collaborative learning that obviously incurs the most substantial transformation when moving into a computer-mediated environment. Communicating in a typewritten medium, where interaction is disembodied from nonverbal cues and, most often, delayed due to members interacting from different places at different times, can be expected to significantly impact the group's work (Feenberg, 1989; Kerr and Hiltz, 1982). Interventions will have to be designed and evaluated during the collaborative learning experience to ameliorate the negative effects of this changed medium as well as to exploit the opportunities that this medium provides.

Individual Accountability

Though the focus in this experience is on the life and work of the group, individual accountability is a key to the group's effectiveness. In the traditional application of this technique, much of the group's interaction takes place out of view of the instructional leader, making aspects of individual assessment difficult. In a computer-meditated environment, much of the individual's performance and interactions are captured in text and are available for closer analysis and feedback.

Interpersonal and Small Group Skills

Students often do not come to school or college with the social skills they need to be effective in collaborating with others in a task. Consequently, instructional leaders often need to teach these skills, which include: communication, leadership, trust, decision making, and conflict management. Further, they need to motivate the members of the group to use these skills in order that the group function effectively. This teaching task is complicated when the activity is taken into a computer-mediated environment. The nonverbal aspect of communication, heretofore so important to teaching these skills, is absent. New strategies for teaching these skills in an on-line environment must be developed along with methods for evaluating their success in facilitating the collaborative learning activity.

Group Processing

The final element essential to constructing and to implementing a successful collaborative learning experience is group processing.

Closely related to the previous element—interpersonal and small group skills—group processing provides the members with the time and procedures for analyzing the functioning of their group and their own use of interpersonal and small group skills. This helps alter the focus of the individual to the larger group and to make judgments about overall effectiveness and his or her relative contributions to the achievement of the group goal (Ausubel, 1963; Bandura et. al, 1963). Central to the success of this is the oversight and timely intervention of the teacher. Again, the change in communication environment will require alteration of monitoring and intervention strategies that may differ significantly from a conventional face-to-face setting.

In any teaching situation, attention to the characteristics of the students is critical to selecting the the appropriate teaching strategy, to structuring the material to relate to their prior knowledge, and to engaging their attention (Bandura, 1963). As individuals come together in groups, they form a collective identity as well. These realities of a given teaching situation take on added importance when the learning experience is taken into a computer-mediated context.

Computer Conferencing Considerations

System characteristics

The literature on individual and group characteristics in the context of computer-mediated communication derives from the research on user interface concerns in information retrieval in libraries. Bennett (1972) underscored the importance of attending to the user as the key in interactive computer systems. He argued that a human engineering approach must be taken where tradeoffs are made among design possibilities, system capabilities, and human use capacity and alternatives.

In work from the same period, Katter (1970) introduced a concept of a user's "line of credit" that is extended to a new system or task involving interactive computing. During this time, the system must deliver the expected benefits before the patience of the user is exhausted. He goes on to suggest that within the "line of credit" period, the user may pass through three stages of development : 1) uncertainty, during which he gains a comfort level about technical competence to effectively operate the system; 2) insight, at which point he sees the underlying systems and principles and sees how to apply the system to accomplish useful tasks; and 3) incorporation, the point at which the use of the system becomes second nature and part of normal work behavior. These findings constitute important guidance for the successful use of computer-mediated communications within collaborative learning contexts. Although there may be increasingly sophisticated software design options available, there seems to be some limit to what a user will undertake and a time within which it must demonstrate a payoff. This is an additional layer of complication to the design of the collaborative learning situation. The novelty inherent during the "line of credit" period must be used to engage the motivation of the learner to proceed with use of the system and the academic task.

In addition to these broad system considerations are two other major factors that must be acknowledged and accommodated: the narrowed communication channel deriving from the exclusive use of typewritten communication and the delay in interaction that is inherent to asynchronous systems. The constriction of the communication channel to typewritten text eliminates nonverbal cues from the interaction process. This phenomenon has been widely studied (Feenberg, 1989; Kerr and Hiltz, 1982; Kiesler et. al, 1984; Waggoner, 1987). The essence of these studies suggest that compensating mechanisms need to be developed and employed to offset the nonverbal dimension that is so integral to most communication in group work. It is particularly important in a teaching situation where learner progress is often monitored by observing nonverbal behavior and where some teacher feedback is given nonverbally. The delayed inter action inherent in most asynchronous systems likewise requires intervention strategies to compensate for the momentum that may naturally develop from the immediacy of face-to-face communication.

The design and implementation of a computer conferencing system in a collaborative learning experience, then, may be said to have two aspects: 1) the design of the technical software system, and 2) the design of the teaching-social system. Both of these aspects require a close look at individual and group characteristics.

Individual and group characteristics

In a 1982 study, Kerr and Hiltz (1982) identified categories and characteristics of individuals and groups that may effect the acceptance and use of a computer conferencing system. The individual variables are in five categories: 1) attitudinal variables; 2) skills and characteristics; 3)demographic characteristics; 4) environmental variables; and 5) psychological variables.

Attitudinal variables include attitudes toward the task. What is the relative importance or priority given the task among the individual's other commitments? What is the attitude of the individual toward the media to be used? This can include not only feelings about computers, but expectations regarding specific systems as well, such as anticipated usefulness, impact upon productivity, and difficulty of use. Further, views toward alternative media need to be considered here; these include telephone, conventional mail, and travel to face-to-face meetings.

Attitudes toward the group also come into play. For example, are the other group members liked, respected, or considered to be an important reference group? Finally, there will inevitably be expectations about how the system will effect relationships within the group.

Some basic skills figure importantly in the evaluation of the use of computer conferencing in collaborative learning. Kerr and Hiltz cite personal communication skills, previous related experience, and physical or intellectual disabilities as such factors. Personal communication skills include reading speed, typing speed, preference for speaking or writing, and general writing ability. Among the previous related experience factors are use of: computers, terminals, other computer-based communication systems. Physical or intellectual disabilities are those that become factors due to the requirements of the computer interface to the communication process.

Demographic characteristics may impact the acceptance and use of the system. These include age, gender, level of educational attainment, and ethnicity, nationality or subculture.

Environmental variables may, likewise, figure importantly. Available resources, including secretarial support may effect system use, as might position of the individual in the organization or their relative status in a more informal group. The amount of pressure to use the system from superiors and peers can also be an important factor.

Finally, psychological variables may influence participation. Personality characteristics and basic values are two dimensions suggested that may interact with the other variables above to affect an individual's acceptance and use of a system in a collaborative learning situation.

Attitudinal and psychological variables characterize the mental set that an individual will bring to the learning activity. These will need to be anticipated and accommodated in order for the collaborative learning experience to effective. Motivations for participation will vary and early identification of incentives and the establishment of mutual expectations will set the tone for the individual's participation. Personal communication skills, previous related experience with the technology, technique, or topic, as well as physical or intellectual conditions may require careful individual attention to insure full participation. Since each individual in a collaborative learning activity has specific responsibilities, this aspect of preparation and monitoring becomes increasingly important. Similarly, demographic and environmental characteristics should provide important information in designing and implementing the teaching social system aspect of the collaborative learning activity in a computer conferencing environment.

Into this complex milieu, another set of variables must be introduced. While individuals possess distinctive characteristics, they also acquire characteristics as they become part of a group. Here too, Kerr and Hiltz (1982) have elaborated factors that may affect the work of a group in the context discussed here. The major factors affecting the work of the group are the structure, leadership, and cohesiveness of the group. Significant among the structural factors are the size of the group, its degree of geographic dispersion, whether control is centralized or decentralized, and the extent to which there have been pre-existing communication ties among the group members.

Leadership has proven to be an important quality in the effectiveness of groups in a computer-mediated environment. The style of the leader and the level of activity figure importantly (Kerr, 1986). This is another parallel to the face-to-face collaborative learning activity. Leadership by the teacher is a key variable in the effectiveness of that teaching and learning strategy.

The cohesiveness of the group can play a key role in the effectiveness of the group. An analysis of sociometric ties can determine whether members: have ever met face-to-face, know each other prior to the activity, have worked together previously, exist as a collection of cliques, have many individualists, or are an integrated group. In addition to the sociometric ties, the relative competitiveness, and degree of trust or openness can affect the work of the work in this collaborative computer-mediated communication environment.

The composition and commitment of the group to the task is important in a structured application of computer conferencing like collaborative learning. Pre-existing ties among group members is an influential favorable variable as group formation has already taken place to a certain extent and movement of the group into the electronic environment may be facilitated as a consequence. Additionally, Kiesler et. al (1984) found that electronic groups were as task oriented as face-to-face groups, but because of keyboard entry time, took more time. They also found that groups participated more equally in an electronic context and were more uninhibited in their remarks than in face-to-face groups. These findings may suggest that this medium may be conducive to use in a collaborative learning activity. Further, because group activity is observable through this medium and other participation variables can be identified with some predictive value, a collaborative learning activity conducted in a computer conferencing environment may be thoroughly planned and evaluated.

Planning Considerations

As can be seen from the preceding sections, there are numerous variables that interact to influence the processes and outcomes of a collaborative learning experience taking place within a computer-mediated communication environment. The orchestration of these variables to enable a productive learning activity requires careful planning.

There are four planning considerations that must be accommodated when developing a collaborative learning activity in this setting:

1) integrate the technical and teaching-social subsystems, that is, adapt key elements of a collaborative learning experience to the computer-mediated communications environment;
2) formative evaluation of member participation;
3) establish outcome measures; and
4) design leadership activity.

All four aspects then need to be viewed as a whole to plan for interaction effects.

Integrate the Technical and Teaching-Social Subsystems

Research and practice in teaching has shown that certain elements must be in place to assure the opportunity for an effective collaborative learning experience. As elaborated above, they involve the design of the teaching strategy and facilitation of individual performance in the context of group work. The replacement of the face-to-face component with computer-mediated communication adds the technical complications of a new communication system to the instructional milieu.

The first step in planning such a collaborative learning activity is simply to check to see the extent to which the five basic elements of a collaborative learning activity—positive interdependence, face-to-face-communication (changed to a computer-mediated medium), individual accountability, interpersonal and small group skills, and group processing—are present and the extent to which planning has been done to account for the foreseen affects of the computer conferencing medium on the process.

Experience has shown that the process of bringing a group together in an online activity, particularly where the group members had not previous known each other, may be significantly aided by beginning with more traditional forms of communication using the telephone, conventional mail, and written explanatory material (Waggoner, 1992). This may be important in collaborative learning, where shared materials and individually tailored assignments figure prominently. In The University of Michigan's Interactive Communications Simulations (ICS), an exemplary use of collaborative learning through computer conferencing, teams of students receive extensive written material that assist them in preparing for their on line experiences. There is also substantial reference material on line (Goodman, 1992).

Planning for the integration of the technical and teaching-social subsystems have been integrated will involve considerable care, as well as attention to other planning considerations.

Formative Evaluation of Member Participation

The formative evaluation of participation by group members is a multifaceted and potentially rich source of planning data for ensuring the efficacy of the collaborative learning experience. There are two main dimensions to this analysis: information related to participation as observed, and as self-reported. The first can include data collected by the computer system regarding frequency and duration of participation, as well as the content analysis of the text of the participants interactions. A number of techniques have been developed for this kind of formative and summative evaluation. Quantitative analysis has been done since the advent of these systems; content and discourse analysis has come along more recently.

The second dimension is self-reported information. This is an important part of the process as well, since it involves comment from the participant about many aspects of the process. For example, some assessment of psychological type may be made through administration of the Myers-Briggs Type Indicator instrument. Other instruments exist or may be developed to ascertain attitudes towards use of various kinds of communication media. Still others elucidate learning styles that may suggest important information to the teacher regarding strategies to employ. Special instruments have been designed to solicit perceptions about efficacy of group function within the computer-mediated process (Waggoner, 1987). Taken together, these methods of collecting self-report data can contribute to the overall picture of what took place and how effective it appeared to be.

Establish Outcome Measures

In a planned collaborative learning activity using computer conferencing, knowledge attainment measures may be constructed and taken . Also, measures related to the efficacy of the design may be implemented to provide feedback for refinement of the model in subsequent applications.

Knowledge attainment can be measured through standard classroom evaluation procedures like examinations, papers, participation in group discussion, among others. The advantage of group discussion on-line is that a verbatim transcript is created that may be reviewed at a later time by the instructor for a closer reflection on the quality of knowledge exhibited by a group member. Outcome measures related to the design of the technical and teaching-social system may be highly idiosyncratic due to the wide variety of conferencing systems in use combined with the unique implementation that may be designed by the instructor. Nevertheless, this aspect of analyzing outcomes for knowledge and system design is important. In both cases, an assessment should be made regarding intended versus actual consequences of implementing a collaborative learning activity using computer conferencing.

Design Leadership Activity

Leadership has been cited as a crucial element in collaborative learning activities in conventional face-to-face settings (Johnson, D. and Johnson, R., 1975; Johnson et. al, 1984). It has also been cited as important in the successful functioning of computer-mediated communication systems (Kerr, 1986). When combining the activity and the medium, leadership is clearly critical. With the leader resides the knowledge of the technical system, knowledge and assumptions about the group members, and assumptions about the relative utility of given teaching strategies in this context. The ability of the leader to intervene appropriately and to guide the overall activity may be the single most important planning consideration.

Conclusion

Planning the use of computer conferencing in a collaborative learning activity involves the orchestration of many interacting variables. The successful implementation of this instructional strategy is dependent upon observing the basic elements of a collaborative learning activity, and accounting for the computer conferencing system characteristics as well as individual and group characteristics with respect to computer mediated systems. Careful integration of these aspects under conscientious teaching leadership can result in a unique and productive group learning experience.

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Writing Apprehension, Computer Anxiety and Telecomputing: A Pilot Study

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Abstract

Is network login frequency related to graduate students' writing apprehension, computer anxiety, age, or years of teaching experience? In a correlational pilot study of 20 educational technology students, writing apprehension and computer anxiety levels were measured both before and after 8 weeks of using electronic mail, computer conferencing, and remote database searching facilities. Results showed that computer anxiety levels measured *after* telecomputing experience were significantly correlated with usage statistics, while writing apprehension scores collected *before* network use were significantly related to login frequency. Graduate students' ages and years of teaching experience were not found to be statistically related to network use.

The academic Internet, a collection of more than 3000 computer networks, now offers a wide range of telecomputing services to between two and five million users from educational institutions worldwide (Quarterman, 1991). Recent estimates indicate that approximately 1%, or 30,000, of those with access to academic online resources are K-12 teachers (Clement & Grundner, 1991). Another 10,000 - 70,000 elementary and secondary teachers use commercial or local telecomputing facilities (Hunter, 1991). An overwhelming majority of these teachers are novice network users.

NSFNET, the Internet backbone network, passes almost 9 billion data packets each month, and is currently growing at a rate of approximately 5% per month (Quarterman, 1991). More than 30% of U.S. K-12 schools now have limited access to telecomputing resources. By 1995, that figure may be in excess of 72% (Itzkan, 1991). Projected growth rates for both network traffic and new users in K-12 environments imply and underscore the immediate need for applicable research results that can guide efforts to introduce and support teachers' use of telecomputing facilities.

The more that we, as teacher educators, know about new network users in K-12 contexts, the better able we will be to help teachers acclimate to, navigate among, and use online resources for educational purposes. Yet little is known about teachers as users of computer-mediated communications. Therefore, the purpose of this pilot study was to explore possible relationships among four novice user attributes (writing apprehension, computer anxiety, age, and teaching experience) and one behavior pattern (network use frequency).

Writing Apprehension

Writing apprehension is "a situation and subject-specific individual difference concerned with people's general tendencies to approach or avoid writing" (Daly, 1979, p. 11). Daly and Miller (1975a) developed and validated the *Writing Apprehension Test* (WAT), a questionnaire designed to measure writing apprehension attitudes. Higher scores on the WAT indicate greater writing apprehension. Lower WAT scores have been correlated with better performance on tests of grammar, writing mechanics, and general writing success (Daly, 1979), more positive perceptions of past successes with writing (Daly & Miller, 1975b), better narrative or descriptive essay writing (Faigley, Daly & Witte, 1981), better American College Test scores, both generally and particularly in English (Richmond & Dickson-Markman, 1985), and better grades in undergraduate composition classes (Powell, 1984).

Shaver (1990) showed that the WAT can be used reliably and validly with secondary school students, and demonstrated that his *Attitudes Toward Writing with the Computer Scale* yields concurrently reliable and valid writing apprehension scores when compared with results from the WAT. It would appear, therefore, that attitudes about writing with computer tools are consistent with attitudes about writing using more traditional media.

Only two studies were found that addressed possible relationships between writing apprehension and network use. In a study of the effects of using computer network technologies on teacher-student and student-student interactions in an undergraduate composition course, Hartman, Neuwirth, Kiesler, Sproull, Cochran, Palmquist and Zubrow (1991) showed that writing apprehension was negatively related to frequency of teacher-student interaction in both traditional and electronic communication modes, although the relationship was weaker for electronic communications. Mabrito's (1991) qualitative study of high-apprehensive and low-apprehensive first-year college writers indicated that "high apprehensives exhibited different strategies than low apprehensives for informing group members about writing during both face-to-face and e-mail sessions" (p.509). The students with high levels of writing apprehension also participated more frequently in electronic writing revision sessions than in face-to-face sessions. It is clear that much more can be learned about the relationship between network users' writing apprehension levels and their use of electronic tools for which writing is necessary for communication.

Computer Anxiety

Computer anxiety is an example of a "concept-specific" anxiety type; anxiousness that regularly occurs in a specific type of situation (Oetting, 1983). Concept-specific anxieties differ from "state" (transitory) and "trait" (personality aspect) anxieties. Although there is no general agreement upon an exact definition of computer anxiety, its presence in educational research literature implies that there is tacit agreement as to its existence (Jones & Wall, 1989-90).

There is some evidence that computer anxiety correlates with math anxiety (Gressard & Loyd, 1986; Rosen, Sears & Weil, 1987; Kernan & Howard, 1990), but conflicting reports exist as to whether it is demonstrated to greater extents in women (Gilroy & Desai, 1986; Jones & Wall, 1989-90). Similarly conflicting results have been published concerning correlations between computer anxiety and age (Rosen et al., 1987; Jones & Wall, 1989-90). The authors of a recent meta-analysis of 81 research reports on computer phobia concluded that computer anxiety is *not* significantly related to either age or gender (Rosen & Maguire, 1990). Computer anxiety levels have been found to be better predictors of success in using computers than is extent of prior computer experience (Marcoulides, 1988), but computer anxiety scores are not related to amounts of computer experience (Rosen et al., 1987; Marcoulides, 1988).

Although computer experience alone does not eliminate computer anxiety (Rosen & Maguire, 1990), there is some evidence that computer anxiety does decrease with structured computer use in educational contexts (Cambre & Cook, 1987; Lambert & Lenthall, 1989). Introductory instruction in word processing has been cited at least twice as an effective way to reduce novices' levels of computer anxiety (Gilroy & Desai, 1986; Harrington, McElroy & Morrow, 1990), especially when compared to introductory instruction in computer programming (Gilroy & Desai, 1986). In one of these studies, undergraduates actively avoided use of the word processor more often than students with lower levels of computer anxiety (Harrington et al., 1990). It may be interesting to discover whether highly computer-anxious novices would similarly avoid use of telecomputing services.

Potential relationships between computer anxiety levels and frequency of telecommunications tool use have been addressed in only one located reference. In a study of traditional-mode and electronic communication among undergraduate writers and their teachers, computer anxiety was found to be a significant negative predictor of frequency of electronic teacher-student interaction. Computer anxiety was also negatively related to frequency of traditional-mode interaction about writing (Hartman et al., 1991). Given the relative paucity of research that explores possible relationships between computer anxiety and network use, further investigation of such connections is certainly justifiable.

Subjects

The subjects that participated in this study were 20 graduate students enrolled in an introductory educational technology course taught (by one of this study's researchers) at a comprehensive midwestern U.S. public university during the fall semester of 1991. The majority were female K-12 classroom teachers. Students explored social, ethical, and pedagogical issues related to the infusion of microcomputer tools into K-12 curricula. They also personally experienced a broad range of instructional computing applications on three different microcomputer platforms in primarily hands-on contexts, including word processing, database and spreadsheet use, computer graphics creation, graphing, Logo programming, educational software evaluation, use of interactive multimedia, and computer-mediated telecommunications.

The students learned to use three different types of telecomputing services: mainframe-based electronic mail (VAX Mail), computer conferencing (Usenet NEWS) at both local and international levels, and direct (Telnet) access to remotely-located online resources. The subjects were required to complete two short telecommunications assignments to demonstrate comfort and competence with electronic mail and computer conferencing, as partial fulfillment of course requirements. In both of the assignments, a minimum number of logins were required, but students were encouraged to further use the services according to their own interests, informational needs, and preferences. Students had unlimited access to network resources for 12 weeks during the semester, the first 8 of which were studied in the context of this research.

Methodology and Instrumentation

The study was exploratory in nature, and sought to investigate statistical relationships between subject network usage, and the subject attribute variables of age, teaching experience, computer anxiety level, and writing apprehension level. Evidence of network use was collected as three separate sets of student login statistics over the 8 week period, with numbers of logins drawn from Campus Computing usage records. These usage statistics are identified within the study by individual monthly totals and across-month totals. "September Usage" represents a total of student logins for the first week of network use, "October Usage", represents the total for the next 4.5 weeks, and "November Usage", represents a total for the last 2.5 weeks of study. All three of these figures are combined into an overall total usage figure for the 8 weeks, which is identified in the study as "Total Usage".

Attribute data were collected both before and after 8 weeks of network use. Age and teaching experience were collected before network use began. Computer anxiety and writing apprehension were measured before network use began as well, but were also measured upon conclusion of eight weeks of student network activity. Investigated variables then consisted of four variables associated with individual subject network use (September Use, October Use, November Use, and Total Use), and six variables associated with subject attributes (age, teaching experience, computer anxiety pretest score, computer anxiety posttest score, writing apprehension pretest score, and writing apprehension posttest score). All data were collected with assurances of student anonymity.

Figure 1. Correlations of Attribute Variables with Network Usage

	Age	Computer Anxiety Pretest	Computer Anxiety Posttest	Writing Apprehension Pretest	Writing Apprehension Posttest	Teaching Experience
Total Usage	-.1747 (p<.461)	-.2715 (p<.247)	-.5815 (p<.007)**	-.4235 (p<.063)*	-.3700 (p<.108)	.0057 (p<.982)
September Usage	-.2649 (p<.259)	-.1785 (p<.451)	-.5597 (p<.010)**	-.4403 (p<.052)*	-.3968 (p<.083)*	.1054 (p<.668)
October Usage	.0089 (p<.970)	-.2151 (p<.362)	-.3539 (p<.126)	-.6607 (p<.005)**	-.3883 (p<.091)*	.2191 (p<.367)
November Usage	.0150 (p<.950)	-.3333 (p<.151)	-.4425 (p<.051)*	-.2723 (p<.245)	-.2193 (p<.353)*	-.1479 (p<.546)

Note: * represents correlations approaching significance at the p<.05 level (p<.1)
** represents correlations found to be significant at p<.05 level

Computer anxiety levels were measured using the *Computer Opinion Survey*, developed at Iowa State University (Mauer & Simonson, 1984), and subsequently standardized with high reliability and validity coefficients (Simonson, Maurer, Montag-Toradi & Whitaker, 1987). This instrument produces a score that can range from 26 to 156, with larger numbers reflecting greater levels of computer anxiety. It consists of 26 statements that reflect personal anxiety with computers and their use. Respondents indicate their level of agreement/disagreement with each statement using a six-point forced choice Likert scale.

Writing apprehension was measured by use of the Daly-Miller Writing Apprehension Test, developed by Daly and Miller (Daly & Miller, 1975a). This instrument produces a score that can range from 26 to 130, with larger numbers reflecting greater levels of writing apprehension. The test consists of 26 statements that reflect feelings of apprehension toward the writing process, and asks respondents to mark their levels of agreement with each statement on a 5-point Likert scale.

Results

Analysis of statistical relationships between variables was facilitated by computing correlation coefficients (Pearson Product Moment), among all six subject attribute variables with each of the four usage variables. Individual correlation coefficients, and corresponding significance levels are provided in Figure 1.

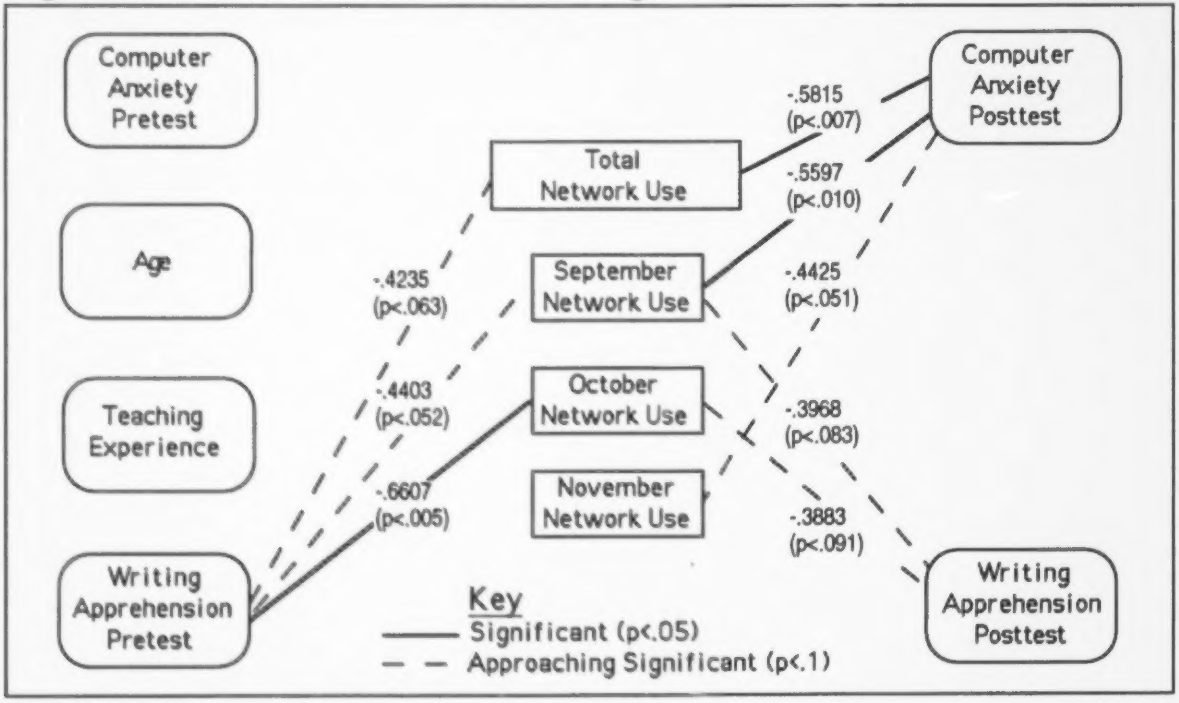
Three pairs of variables were found to have correlations considered to be statistically significant (p<.05). These were:

1) the writing apprehension pretest score with October network use
(-.6607, p<.005),
2) the computer anxiety posttest score with total network use
(-5815, p<.007), and
3) the computer anxiety posttest score with September use
(-.5597, p<.010).

Due to the exploratory nature of the study, five correlations between variables were also identified as "approaching significance" (p<.1). These were:

1) the writing apprehension pretest score with total use
(-.4235, p<.063),
2) the writing apprehension pretest score with September use
(-,4403, p<.52),

Figure 2. Factors Related to Network Usage



3) the computer anxiety posttest score with November use
(-.4425, p<.051),
4) the writing apprehension posttest score with September use
(-.3968, p<.083), and
5) the writing apprehension posttest score with October use
(-.3883, p<.091).

A summary of these significant and approaching significance statistical relationships is provided in Figure 2.

Three of the six attribute variables (computer anxiety pretest score, age, and years of teaching experience) were found to have no significant or approaching significance relationships with any of the four usage variables. Thus only the writing apprehension pretest scores, the computer anxiety posttest scores, and the writing apprehension posttest scores were considered to be statistically related to student network use. All the correlations associated with these three variables were negative in sign, suggesting that in general, lower levels of writing apprehension and computer anxiety were associated with a greater use of telecomputing facilities.

Discussion

Although the study was exploratory in nature, and therefore cause and effect cannot be determined, implications related to teacher training in telecomputing can be gleaned from observed statistical relationships. Perhaps what is most interesting is the contrast between observed relationships of network use with computer anxiety pretest and posttest scores. No significant relationship was found between computer anxiety pretest scores and *any* of the usage variables, suggesting that a student's initial level of computer anxiety had no relationship to their eventual use of telecomputing resources. Perhaps concern related to whether highly anxious computer users will actually use network facilities are unwarranted, since in this study, there was not a significant relationship observed between these two variables. It should be noted, however, that this finding was in direct opposition to one aspect of the results of another recent study, in which computer anxiety levels did, in fact, significantly predict subsequent numbers of electronic interactions (Hartman et al., 1991).

Interestingly, there was a significant relationship calculated between student use of network resources and computer anxiety *post*test scores. The negative correlation observed suggests that greater network use was associated with lower computer anxiety. Such a relationship implies that use of telecomputing tools may help to lower student computer anxiety. Later studies will need to incorporate a control group that does not use network facilities to determine if there is indeed a cause and effect relationship. This study suggests that the potential of a such a relationship exists. Perhaps a beneficial outcome to using telecomputing tools with students is their increased comfort with general computer use.

Writing apprehension, in contrast to computer anxiety, was primarily related to network use through the *pre*test writing apprehension score. The negative correlations observed with this variable suggest that higher levels of writing apprehension were associated with lesser login frequency. Such a result implies that students' initial writing apprehensions may work to hinder their use of network resources, although results from a study using a control group would be needed to determine this for certain. To encourage active network use, an instructor may want to address any initial student apprehensions related to the writing process before introducing telecomputing tools. Although Daly and Miller (1975a) called for research into reducing writing apprehension with behavior therapies such as systematic desensitization and/or counseling when the WAT was first released, no published evidence of systematic study in these areas was found. Although the writing apprehension posttest score was not significantly related to network usage, two correlations did approach significance. Such a result suggests that there may be some potential benefits in using telecommunications tools in dealing with general student writing apprehension. This may be a worthy area for further investigation.

It was particularly encouraging to find that there was *not* a significant relationship observed between pretest or posttest computer anxiety and writing apprehension levels (pretests: -.2467, p<.260; posttests: -.3226, p<.160). This evidence would support the conjecture that computer anxiety and writing apprehension are indeed separate constructs within the study, and were not simply indications of student state or trait anxiety. This implies corroboration with at least two other studies in which computer anxiety was related to state and trait anxiety, but with very low predictive validity (Rosen et al. 1987; Kernan & Howard, 1990). It is also interesting to note that neither subject age nor amount of teaching experience were found to have be significantly correlated with network use, implying that teacher age and teaching experience are potentially minor concerns when planning K-12 telecommunications infusion.

The results of this pilot study of user attributes' relationships to novice network login frequencies suggest that future research should focus upon anxiety level *outcomes* of computer-mediated telecommunications, rather than upon usage predictions. If it can be established that use of telecomputing tools does indeed cause significant change in either/both computer anxiety and/or writing apprehension, methods and contexts with/within which these changes occur should be empirically explored and shared.

Predictions based upon current statistics indicate that telecomputing in teacher education is here to stay (Clement & Grundner, 1991; Hunter, 1991; Itzkan, 1991). Eventual use of network resources for a majority of computer-using teachers and teacher educators is not a matter of choice; it is a matter of imminence. We must now concentrate upon how best to assist novice telecommunicating teachers in their networking exploits. Such research should begin with study of the users themselves.

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The Jason Project Experience and Attitudes Toward Science as an Enterprise and Career

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Abstract

Advanced telecommunications technology, supported by written curriculum materials, was used to broadcast a series of undersea explorations for observation by students (grades 4-12) across the U. S. and Canada (The Jason Project). The goal of this project was to enhance science interest among students and their teachers, and to inspire students to pursue science careers. Pre and post-test data on participant attitudes toward science from 367 male and 339 female students were collected at one downlink site. These data reflect significant pre-post gains in attitudes toward science among both male and female Jason participants. Science attitudes were found to be composed of emotional and intentional factors. Significant differences were found in science attitudes when students were nested by teacher sex, suggesting that male and female teachers may approach science teaching with different pedagogical strategies. Multivariate analysis of the factor scores from participants science attitudes revealed that students who had female science teachers reported more positive emotional reactions to science than did those students who had male science teachers. Further, although female students viewed science as a sex-neutral field, male students still viewed science as a largely male domain. Comprehensive interventions, such as the Jason Project, that are designed to enhance science interests, combine the talents of scientists, engineers, science educators, curriculum specialists, career psychologists, and communication technologists in an unusually effective manner.

Considerable documentation exists on the recent decline in science interest among high school students (Dresselhaus, 1984; Thomas, 1986), and of the effects of science course deselection during the high school years on retention in the science career pipeline (Betz, 1990; Fox, 1979). Further, the shift from science to non-science careers during the college years has been well documented (Astin & Panos, 1969). Despite this overall decline in science interests, and the importance of the implications of this decline, few direct attempts have been made to heighten scientific interests or to study how science interests form. As a result, we know very little about the psychological processes involved in the selection of science careers.

Modest alterations in the level of interest in an occupation have been achieved using written or audiotaped informational interventions (Malett, Spokane & Vance, 1978; Osipow, 1962; Prediger & Noeth, 1979). Similarly, attitudes toward science (among teachers), which can be considered to be a special occupational instance, have been enhanced using visual or written communication channels separately (Demers, & Shrigley, 1990). It should be possible, by combining written, visual, audio, and interactive communication channels, to markedly alter attitudes toward science generally, and, more specifically about science as a career possibility.

The Jason Project is a five-year program of undersea exploration which utilizes a sophisticated network of telecommunications technology, to provide live telecasts from remote sites enabling students to observe and participate in the process of scientific discovery as it occurs. The Jason Project seeks to improve science attitudes of teachers and students in grades 4-12 through "telepresence", the use of telecommunication technology to create a simulated presence at a remote site. This experience is enhanced by a special curriculum emphasizing hands-on learning designed by the National Science Teachers Association (NSTA). One goal of the Jason Project is to inspire students to pursue scientific careers.

Twelve science museums across the country participated in the 1989 project via satellite link-up with the command ship, Star Hercules, in the Mediterranean Sea. Jason, the robotic, camera-equipped vehicle explored a 1600-year old Roman shipwreck, and documented the first known hydrothermal vents in the Mediterranean. Simultaneously, thousands of school children attending the live transmissions at the twelve museum sites across the country shared the excitement of these discoveries with Dr. Robert Ballard and his team of scientists. In the second Jason expedition, 150,000 students from the United States and Canada explored the sunken Battle of 1812 warships, Hamilton and Scourge at the bottom of Lake Ontario through telepresence.

To enhance the educational impact of the Jason Project the National Science Teachers Association (N.S.T.A.) developed a special curriculum for grades 4-12 for each of the Jason expeditions. This curriculum featured hands-on activities dealing with technology, physics, biology, geology, history, and social studies, including the specific technologies that make telepresence possible—i. e., robotics, satellite communications, and sonar exploration. Participating teachers were trained in the use of the curriculum during an in-service training workshop held several months prior to the Jason telecast.

Although three informal evaluations of the Jason Telepresence experience (see Bazler & Spokane, 1991 for a review of these evaluations) suggested that the experience was enjoyable for participants, these preliminary studies provided no rigorous outcome data. To provide such data, an intensive, exploratory outcome study was undertaken at one downlink site (Lehigh University) to assess the impact of the multichannel Jason Telepresence experience on student and teacher attitudes toward science (Bazler & Spokane, 1991).

Method

Sample

Two thousand student questionnaires were distributed to teachers at the inservice training conducted for the Lehigh Valley Jason Project. Of those two thousand, 706 also completed posttest questionnaires immediately following the Jason Telepresence experience. Obviously, this return rate reflects the non-participation of several schools, and, thus, the return rate of 35% although disappointing, reflects this systematic non-participation. Nonetheless, this rate represents an improvement over previous evaluations (Bazler & Spokane, 1991).

Instruments

Teacher participants who attended the inservice workshop conducted by NSTA completed a fourteen-item semantic differential indicator of attitudes toward science, and the Science Attitudes Scale (SAS) a 22 item Likert-scaled measure of teacher attitudes toward science, adapted from Thompson & Shrigley (1986). Internal consistency for the SAS has been found to be .91 using Cronbach Alpha. Previous factor analyses revealed 4 varimax rotated factors tentatively labeled "teacher preparation", two "discomfort" factors, and a "student motivation" factor (Thompson & Shrigley, 1986).

Student participants completed the Fennema Sherman Mathematics Attitude scale (Fennema & Sherman, 1986), a 108-item, 5 position Likert scale with 9 subscales (confidence, mother, father, success, teacher, male, usefulness, anxiety, effectance). The 72 item version of the original scale was adapted for use in measuring attitudes toward science. The original Fennema-Sherman scale had split-half reliabilities ranging from .86 - .93, and modest intercorrelations on a sample of 1600 high school students.

Students also completed a 14 item semantic differential scale (SD) (Osgood Suci, & Tannenbaum, 1957) tapping reactions to science as an enterprise that was designed for this study using standard SD item structure.

Procedures

A packet containing a sufficient number of questionnaires for each student in a class was given to 100 teachers who participated in the Jason expanse at Lehigh University. The teachers completed the pre-test at the inservice training session and teachers were instructed to administer the student questionnaires prior to the beginning of the NSTA Jason curriculum unit. Only those students for whom pre-test data was available were given the post-test questionnaire.

Analyses

T tests were used to ascertain pre-post changes in teacher and student attitudes. In addition, two factor analyses of the student responses were conducted; the first to analyze the underlying dimensions in the semantic differential indicator of reactions to Science as an enterprise, and the second to reveal the factor structure of the 72 item Science Attitudes Scale. Factor scores were then calculated on the first six factors, and a multivariate analysis of covariance was conducted by teacher on these factor scores.

Multivariate analysis of covariance (MANCOVA), with pretest scores as covariates, was used to examine pre-post changes in science attitudes and aspirations among teachers and students. Samples were blocked using sex, grade, and by teacher to ascertain group differences in response to telepresence. Finally, an analysis was conducted separating females who had female teachers from females who had male teachers and males who had female teachers from those who had male teachers.

Results

Fifty-two percent of Jason participants were male, and 48% were female, with a distribution by grade level skewed toward the elementary and junior high school levels. There were 32 teachers who had students with complete pre and post-test data.

Reliability

Internal consistency (using Cronbach Alpha) for the 14 item semantic differential measure of science impressions and the measure of science attitudes was .93 and .92 respectively for students and teachers. Internal consistency for the overall measure of science attitudes was .42 & .51 for students and teachers respectively.

Factor analyses

Table 1 describes the varimax rotated factor structure for the two outcome measures used in this study (14 item Semantic Differential Scale and 72 item Science Attitudes Scale). As can be seen from this Table, a two-factor structure (Eigenvalues > 1.0) emerged which accounts for 57% of variance in student pre-test scores. Inspection of the factor loading's for the first factor suggest that the first factor (Eigenvalue = 6.90, % variance= 49.3) appears to tap the emotional reactions students feel toward science (e.g., attractive, pleasant, intriguing, excitement, preferred, satisfying, glamour). The second factor, (Eigenvalue = 1.10, % variance = 7.9) in contrast, appears to tap the professional value of science as an undertaking (e.g., important, valuable, professional, rewarding). This two factor structure suggests that reactions to science may contain both an emotional and an action component, a

Table 1.
Varimax Rotated Factor Structure for the 14 item semantic differential scale and the 72 item Science Attitudes Scale.

Semantic Differential Scale

Factor	Eigenvalue	Percent of variance	Cumulative percent	Factor Label
1	6.89788	49.3	49.3	Emotional Reaction
2	1.10487	7.9	57.2	Professional Value

Science Attitudes Scale

Factor	Eigenvalue	Percent of variance	Cumulative percent
1	18.16324	25.2	25.2
2	5.43863	7.6	32.8
3	3.31725	4.6	37.4
4	2.02866	2.8	40.2
5	1.92977	2.7	42.9
6	1.69951	2.4	45.2
7	1.28269	1.8	47.0
8	1.26199	1.8	48.8
9	1.19607	1.7	50.4
10	1.11760	1.6	52.0
11	1.10971	1.5	53.5
12	1.07424	1.5	55.0
13	1.04172	1.4	56.5
14	1.00863	1.4	57.9

Table 2.
Analysis of Covariance of Student (N=706) Impressions of Science as an Enterprise and Science Attitudes Nested by Teacher

Source	SS	df	MS	F	p
14 Item Semantic Differential Scale					
Covariates	565.83	1	565.83	919.92	.001
Pretest Scores	565.83	1	565.83	919.92	.001
Main Effects	62.17	31	2.01	3.26	.001
Teacher	62.17	31	2.01	3.26	.001
Explained	628.00	32	19.63	31.91	.001
Residual	408.42	664	62		
TOTAL	1036.41	696	1.49		
72 Item Science Attitudes Scale					
Covariates	9.52	1	9.52	187.93	.001
Pretest Scores	9.52	1	9.52	187.93	.001
Main Effects	3.82	31	.12	2.45	.001
Teacher	3.82	31	.12	2.45	.001
Explained	13.36	32	.42	8.24	.001
Residual	34.10	673	.05		
TOTAL	47.46	705	.07		

common finding in SD studies (Osgood et al., 1957).

Table 1 also contains the (pre-test) factor structure of the 72 item science attitudes scale. The varimax rotated structure revealed a 14 factor structure (Eigenvalues > 1.0) indicative of a complex set of science attitudes among the students studied. This factor structure accounts for nearly 60% of the variance in pre-test science attitude scores. Visual inspection of the first six factors (% variance > 2.0) using items that loaded .50 or greater revealed the following labels 1: Factor 1. Negative emotional reaction to scienceFactor 2. Intentions to use science later in lifeFactor 3. Science as a male activityFactor 4. Science as a fun puzzle to be solvedFactor 5. Serious investment by science teachersFactor 6. Encouragement from science teachers about progress

Pre-post changes

Two-tailed t tests were used to compare pre and post test scores on the two outcome measures for students and teachers. On the 72 item science attitudes scale, there was a significant pre-post difference (t = 2.05, p <.04), and a non-significant change on the 14 item SD scale (t = 1.88, p <.06). Not surprisingly, a very marked ceiling effect was found in the teacher data on both outcome scales (i. e., science teachers had very high mean scores at pre-testing), and, thus, there were no significant pre-post differences in the teacher data.

Teacher-student sex pairings.

Table 2. is a summary of the analysis of covariance of student impressions of science, nested by teacher. As Table 2 indicates, there was a main effect for teachers on both outcome measures, indicating that students taught by some teachers gained more from the Jason experience than those taught by others (F=3.26, df= 1, 31, p>.001). This covariance analysis was replicated on the 72 item science attitudes measure with the same outcome—a significant teacher effect (F= 2.45, df=1, 31, p< .001).

When factor scores were calculated for students on the 72 item science attitudes scale, it was clear that the significant teacher/student sex pairings occurred on two of the factors; factor 1, negative emotional reactions to science (F = 15.36, p < paired with female teachers had more positive emotional reactions to science, (see Table 4.), whereas male students, whether paired with male (X = 4.32) or female (X = 4.27) teachers had higher scores on science as a male activity than did their female counterparts (see Table 4.).

Table 3.
Analysis of Covariance of Post-test Means and Standard Deviations of Global Measure of Reactions Toward Science as an Enterprise by Student and Teacher Sex

Source	SS	df	MS	F	p
Covariates	164.60	1	164.60	242.55	.001
Main Effects	5.94	2	2.97	4.38	.013
Student Sex	.48	1	.48	.71	.401
Teacher Sex	5.76	1	5.76	8.50	.004
2-Way Interactions	.51	1	.50	.74	.39
Explained	171.04	4	42.76	63.01	.001
Residual	190.01	280	.68		

Table 4.
Mean Factor Scores for Male and Female Teacher and Student Pairings.

Factor 1. Emotional Reactions to Science			
		Teacher Sex	
		Female	Male
Student Sex	Female	3.77	3.43
	Male	3.81	3.43
Factor 3. Science as a Male Activity			
Student Sex	Female	3.43	3.06
	Male	4.27	4.32

In the post-test Jason Project evaluation data, an unexpected curvelinear relationship was found between student grade and post-test impressions of science as an enterprise.

Discussion

Science attitudes are a complex blend of emotional reactions and intentional attitudes. It is apparent that positive outcomes in both of these attitudinal domains are associated with the Jason experience. The complex factor structures found in this study, however, suggest that we can no longer presume that simple interventions to enhance science attitudes will have universal linear effects. The various emotional and attitudinal components of science attitudes may be differentially affected by specific elements of interventions such as the live Telepresence broadcast or the curriculum component of the Jason experience. We underscore the need for comprehensive interventions such as the Jason Project which combines the expertise of scientists, science educators, telecommunication technologists, career psychologists, and curriculum specialists. A positive emotional reaction, achieved by the live broadcast, even if effective in modifying emotional reactions, may be insufficient to stimulate science activities and course selection or to result in science career pursuit. We cannot, of course, from this preliminary evaluation, know which component of the experience produced any positive effects. Further, these data were derived from a single downlink site and may not be representative of the more than 250,000 students who participated nationwide. An extension with a no-treatment or matched treatment control, and separate evaluations following each Jason component is in the planning stages.

The Jason Project data revealed a curvelinear relationship between the students' grade in school and the effect of the Jason experience (i.e. middle grades showed more gains). This unexpected finding may suggest that middle schools are the more appropriate grade target for interventions to increase science interests (e. g., elementary grades are too early, and high school is too late to affect interests). It may also be possible that interests in science simply peak during middle school years.

Although there were no significant increases in teacher attitudes toward science, their pre-test scores were very high to begin with (ceiling effect), thus indicating a substantial amount of positive feeling toward their subject matter. Thus any differences in their outcomes with students may have more to do with their teaching methods or with their students' reactions to their styles and methods than with any differences in motivation among the teachers for engaging in science as an enterprise. There were no significant overall differences between male and female Jason participants in the gains received—a finding that is contrary to some widely held views about the attractiveness of science to women. It does seem clear, however, that the pairing of male and female teachers and students does affect the Jason outcomes. Students who had male teachers were less positive about the Jason experience than those who had female teachers. It may be, of course that female teachers simply used more of the NSTA curriculum than their counterparts, or, that the female teachers were simply younger or more enthusiastic. When the student data were recoded using factor scores, however, it seemed apparent that most of these teacher differences were attributable to the students' emotional reactions to science. It is possible that male teachers were less able to influence the emotional reactions of both male and female students, and were, therefore, perceived as less supportive of science behaviors in a climate where may students are avoiding science because of fears about the difficulty of the subject matter. We were heartened by the finding that young women no longer consider science to be a male domain, but concerned that most young men may not share that belief. Male reactions to women entering science may be as crucial to those women's success as those women's personal reactions. Attempts to influence science attitudes must include a combination of emotional and behavioral strategies if they are to be more universally effective.

For the present, these data serve as a confirmation of the beneficial effects of a comprehensive science interest enhancement such as the Jason experience for students and their teachers, and a springboard for more systematic and analytic studies of both telepresence as a teaching method, and the development of science attitudes and career preferences.

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Reference Notes

1 The complete set of means, standard deviations, factor loadings, and F tables is available from Arnold R. Spokane, 233-A Iacocca Hall, Lehigh University, 111 Research Drive, Bethlehem, PA 18015.

2 This research was part, by funds from the Jason Foundation, Turner Broadcasting, Electronic Data Systems, the Iacocca Institute, Lehigh University; The College of Education, Lehigh University; The College of Engineering and Applied Sciences, Lehigh University through the generosity of Mr. Glenn Gibson; the Dwight D. Eisenhower Mathematics and Science Education Act Public Law 100-297 from the Pennsylvania State Department of Education; School Districts in Eastern Pennsylvania and New Jersey; Dioceses of Allentown and Scranton; Air Products and Chemicals Inc; Union Pacific Corporation; Pentamation Inc; IBM Corporation; Bethlehem Steel Corporation; and The Morning Call. The authors are indebted to Tim Armour, James Gunton, Jim Harper, Lawrence Hecht, Frank Ireton, Bill Johnson, Alden Moe, Patti Oda, Henry Odi, Alan Pense, Christie Smith, and Diane Spradlin for assistance throughout this effort, and to Fran Ryan, Jackie Massa, and David Krem and the Carbon-Lehigh Intermedite Unit #21 for technical support.

THEORY

Section Editors:
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The papers in this section represent an encouraging trend to think critically about the place of technology in teaching and teacher education. If the early years of school microcomputing can be characterized (at their most negative) as a headlong rush to adopt computers without much forethought or planning, or (in a more optimistic vein) as a necessary period of trying out new machinery and new applications, then perhaps we have now had enough of this type of experience to have entered a new phase of reflecting on the meaning of technology in education.

Taken all together, these papers illustrate a general movement toward the elaboration of alternative paradigms for thinking and working with technology. No longer, they say, can we be satisfied with simply trying to apply computers and other new technologies to standard curriculum in the same way we would apply a new textbook. Instead, experience has shown us that computing offers a set of new potentials and new characteristics that affect how students learn, how teachers teach, and how learning situations are optimally constructed. These new possibilities and alternatives must be spelled out and studied so that they can be embodied effectively in education.

In the first place, as two of the papers point out, *change is not automatic but depends, at least partly, on the way we think and do about it*. Francoise Herrmann, in **Metacognition in Computer-Assisted Language Learning** (CALL) draws our attention to the importance of the metaphors we use in describing new situations. She describes several common metaphors for computing in education (e.g., tool, pedagogue, workhorse) and their resulting applications. The point is that how we conceptualize computers makes a difference in how eventually use them, and thus the activity of metacognition—thinking about our own thinking—can be invaluable in helping teachers understand and critique how computers are being used, as well as to create innovative uses for them. (Herrmann's own conceptualization is described below.)

Lamont Johnson, Steve, Harlow, and Cleborne Maddux, in **Can Technology Fix Education? Are We Waiting for Godot?** ask why it is that computing is not playing a more important role in education. Although many of us, as they put it, "feel that something is missing in the educational process and that something important is about to happen," too much of the time we talk to ourselves and take little action to change education. They list three ways teacher educators can begin to be proactive instead of reactive: model technology in our own courses, work and talk collaboratively with colleagues in methods and curriculum, and practice our ideas in projects with

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schools. Thus change depends on how we think about it, but also, having thought, what actions we take.

A second theme running through several of these papers is that *one condition for effecting change is understanding the new relationships between learner and teacher, or new educational settings and configurations, that the new technology is bringing about.* Andrew Chirwa, in **Conceptual Framework for Incorporating the Learner into the Technology Environment,** develops a model for thinking about the relationship between the learner and technology. The relevant factors in his model are the student, the teacher, human wants and needs, and the technology. In discussing the dynamics of the model he focuses on how the self-actualization of the student is related to the interaction between teacher and student, society and its values, and the process of linking the learner to technology tools. He argues that as educators reflect on curriculum development, instructional theories, educational philosophy, learning and teaching strategies, learning environments, and the evaluation of programs they can actively shape all of these factors to facilitate the incorporation of the learner into the technology environment.

Like several other writers in this section, Ray Schipke, in **Linking LAN Writing and Group Approach: A Preservice Laboratory Approach,** emphasizes the social and collaborative potentials of computing. She argues here that local area networks (LANs) have inherent social dimensions that provide a supportive context for collaboration. This has important implications for teachers in a writing laboratory: "Instead of being a didactic conveyor of knowledge, the teacher's role is to establish a collaborative helping relationship with his or her students." Most teachers, however, receive no training either in using computers collaboratively or in how they should behave in such a setting. They must learn, for instance, the art of "sharing responsibility for leadership with students...without relinquishing their own authority or control." Teaching in a LAN laboratory thus necessitates an expanded and collaborative view of authority relations.

In a second paper, Francoise Herrmann discusses how the design of technological applications influences how and what students learn. **An Instrumental/Agentive Framework in Computer-Assisted Language Learning (CALL)** presents two alternative designs. An agentive design emphasizes the careful sequencing of instruction in discrete steps in a behaviorist fashion; language is viewed as manipulable parts and computers are used for drill. In an instrumental design, on the other hand, computer tools are used in an open-ended way, support collaboration, learning is viewed as holistic, and the use of language is socially grounded. In the latter design, which Herrmann illustrates through a project to increase computer access and basic literacy of low-income and minority elementary children, the relation between technology and the user is dialectic, "as the machine depends for its design on the uses to which it is put, while learners and their teachers tend to reconsider their activities as they integrate use of the technology in their activities."

The effective incorporation of technology can be tracked by the degree to which individuals are able to transfer use in one setting or application to use in other settings and applications. Esther Javetz reports the initial findings of a qualitative study that looked at how a sample of schools and school personnel incorporated technology into their programs. In **Technology in Schools: Repetition or Transfer?** she presents two models and identifies factors we must consider if we hope to prepare teachers who will be able to incorporate technology effectively into their classrooms and instructional programs.

Beyond the changes in social relations and educational settings implied by new computer technologies, some of these papers focus on *the curricular goals of emerging paradigms, relating how we want students to think and what we want them to learn to the potentials of the computer.* Donald Lind, for example, in **Teaching to Higher Cognitive Levels by Means of a Computerized Conceptual Model** suggests that one of the most important contributions the "computer age" may make to teaching and learning is the opportunity it provides to develop students' higher level thinking skills. In this paper Lind offers a model for using technology to enrich students' conceptual understanding.

In **Technology and Teacher Education: Paradigm Shift in Instruction?** Allen Henderson advocates using technology to help move from the dominant lecture paradigm to one featuring a guided inquiry approach. He argues that technology can facilitate major aspects of guided inquiry: incorporating learning centers into the classroom, self-paced and self-managed activity, collaborative work, the integration of subject areas, and more. He emphasizes the importance of educating teachers about these changes. We must, he says, "go beyond the literacy approach of showing teachers how to operate technology." This is especially important since "educators underestimate the logistical challenges of implementing technology in the classroom and the support needed by teachers who are attempting to integrate technology into instruction."

In much the same vein Juanita Copley, in **The Integration of Teacher Education and Technology: A**

Constructivist Model, argues that we must move from a didactic teaching model to a constructivist one in which teachers act as facilitators in helping students become active participants as they construct their own understandings and capabilities. Crucial for teachers in this conception is the ability to model the learning process using technology. Copley reports on the results of an experimental study with preservice teachers that indicated the effectiveness of a constructivist approach.

The impact of these papers is to show that optimal use of technology in education is not simply a matter of attaching computer applications to existing curriculum practices. The process is in reality more complex and requires an understanding of both how technology can be used and one's goals in using it. Technology can alter social relations, methods and teaching and learning, and educational settings. Whether it will do so depends on how we think about technology in education and on what we do with our knowledge. These papers are an encouraging sign that we may be on our way to conceptualizing and implementing the change to a new paradigm of learning with technology.

Howard Budin has been active in working with teachers to implement new technologies for the past ten years. Most of his current activity centers on incorporating computers into cooperative learning and problem solving. He currently heads a SIG in Computers and Cooperative Learning for the International Association for the Study of Cooperation in Education (IASCE).

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An Instrumental/Agentive Framework in Computer-Assisted Language Learning (CALL)

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Introduction

Agentivity in Computer-Assisted Language Learning (CALL) subsumes anthropomorphic designs (e.g., Tutors, DrillMasters and TaskMasters). Instrumentality subsumes open-ended designs. Word processors, E-mail and data bases can support collaborative activity systems (e.g.; newspaper production). This will be exemplified in the preliminary results of an evaluation study of the Neighborhood Computer Centers after-school program.

Instrumental and agentive designs

Current uses of the computer in computer-assisted language learning (CALL) tend to be anthropomorphic and progenitive (extrapolated from Dretske, 1985). Designed as brightly colored Tutors, DrillMasters, and TaskMasters computers are endowed agents in learning and teaching processes. They determine the subject matter, the paths of knowledge acquisition, and what constitutes successful performance. Functioning as discrete adjunct learning and teaching contexts (in the classroom or in the computer lab), this design of computer technology tends to be logically related to various curriculae rather than practically integrated in the dynamics of classroom action.

Alternatively, an instrumental design of computer technology exists. Designed as word processor, data bases and, communication networks, for example, computers can function to create and support collaborative activity systems in the classroom. As open-ended applications that are not bound to subject matter these designs can operate to mediate such collaborative activity systems as the production of a classroom newspaper across distant sites (Barson and Frommer, 1989), the creation of a data base of book reviews (Herrmann, 1991), international forums of communication focused on environmental issues (KIDS-91, The Copen Family Fund, 1991), and the simulation of a peace conference among students located at distant sites (Brecht, Noel and Wilkenfeld, 1983). Users in these contexts are the agents of a larger system of meaningful relations where they have committed to purposeful action and personally meaningful goals. The relationship between the technology and users is a dialectical one as the machine depends for its design on the uses to which it is put, while learners and their teachers tend to reconsider their activities as they integrate use of the technology in their actions.

Underlying assumptions

Corresponding to each of these distinct designs of computer technology in CALL there are radically opposing assumptions about what constitutes the object of learning (i.e., language) and the processes by which it is imparted (i.e., learning and teaching).

In an agentive design of computer technology, language is viewed in parts that can be manipulated. The user thus works with language objects such as morphological and inflectional variations which s/he can transform through such manipulations as substitution, deletion, and insertion. This objective view of language operational in agentive technology is borrowed from such linguistic theories as structural and transformational grammar (e.g. Bloomfield, 1945; Chomsky, 1957). In harmony with this view of language learning processes in an agentive design are viewed as rote memorization and practice while teaching is understood to involve the careful sequencing and presentation of the building blocks of learning. Thus, intelligent applications offer such features as drill and exercise coupled with evaluation modules to determine levels and areas of practice. These features of agentive designs and the views of learning and teaching they mirror are borrowed from such learning and teaching theories as those found in the behaviorist paradigm (e.g.; Skinner, 1957) and the audio-lingual method for foreign and second language learning.

In contrast, in a instrumental design of computer technology, the view of language is open-ended. Language belongs to the agents of the activity systems who use it to perform various tasks and actions, several of which recursively involve the use of technology. Thus, the agents of a newspaper production activity, for example, may use language outside of the machine to visit an art exhibit for a review article. This use of language will be recursively called up and transformed as students write their article on the word processor, communicate via e-mail with peers and their teacher for comments and suggestions, and subsequently format the article as part of a larger collaborative product (i.e., the newspaper). Thus, the view of language operational in the design of instrumental computer use is both holistic and socially grounded. It may be considered as borrowed from such theories of language as speech acts (e.g.; Austin, 1962) and pragmatics (Ducrot, 1980). Similarly, learning and teaching processes in an instrumental design are hypothesized to occur in an educational space termed the Zone of Proximal Development (ZOPED) where learners "stretch" all of their resources to accomplish tasks at hand and through inter and intra-action among agents of the activity system (Griffin and Cole, 1984; Belyaeva and Cole, 1989). As intra-action learning is hypothesized to occur when participants integrate new uses of language. As inter-action learning is hypothesized to occur between students and their teacher when the tasks at hand are beyond solo action. In light of this conceptualization borrowed from Soviet Activity theory (e.g.; Leont'ev, 1981; Wertsch, 1981) and a contemporary socio-cognitive paradigm of education (Langer and Applebee, 1986), teaching functions are reconsidered to include such multipurpose roles as resource person, tutor, activator, initiator, support person, and expert (Barson, 1991). Thus, instrumental technology does not attempt to reproduce the learning processes and teaching praxis of its agents; rather, it functions as a mediating tool that both extends and transforms the potential of its agents.

Exemplification

The Neighborhood Computer Centers (NCCs) after-school project was designed to increase the computer access and basic literacy of low-income and minority elementary school children (Schiorring, 1991). For two hours a week, 9 groups of children at four distinct locations come to work at the NCCs. The computer application in use at the NCCs is The Learning Company's *Children's Writing and Publishing Center* with one location using Sunburst's *Magic Slate*.

Preliminary findings of an evaluation study demonstrate that while the publishing functions of the program across such distinct areas of the NCC curriculum as science, social studies, and basic literacy are not used, use of the technology (and the dialectical forces of change it carries) created a context for the development of a cross-disciplinary program. As program developers discovered, the process of using instrumental technology did not subsume a set of pre-established activities, learning and teaching objectives, and learning content. Thus, the success of the NCCs is one of innovative curriculum development and sheer enthusiasm focused on community action that has evolved across traditional boundaries to include activity in science and cultural journalism.

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Can Technology Fix Education: Are We Waiting for Godot?

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Abstract

The authors use Samuel Beckett's drama *Waiting for Godot* as a metaphor for the delay in changing education through technology. In the play, the characters wanted to see action, but waited for Godot. Godot never came, and the characters never acted. The authors suggest three ways that teacher educators who work with technology can become proactive and start change: Model the use of technology in teacher training courses, invite colleagues into a dialogue about the application of technology to skills and subject areas, and take ideas to the schools where they can be shared with, and tested by, practicing teachers.

Regardless of the unfairness of the criticisms being leveled at us, we can all agree that American education needs some fixing. Obviously technology alone cannot fix education. As members of the Society for Technology and Teacher Education (STATE), however, we share the vision that technology can play an important role in this fixing. A review of the literature on educational technology reveals that many ideas have been put forth for using technology to fix education. These ideas range from Papert's Logo to the plethora of integrated learning systems available. Despite the claims, there is a paucity of evidence to show that any wide ranging change has really occurred. At this point in our mission we must ask: If technology can improve education, what are we waiting for? The answer might be that we are waiting for Godot.

Samuel Beckett (1954) in his play *Waiting for Godot*, addressed the problem of change in this way. Five characters in this play, each possessed by concerns, abdicated the opportunity to seize the occasion to act. They instead surrendered to the impulse of waiting for a force outside themselves to bring order and meaning to their personal situations.

The characters reason together "If he [Godot] comes, we'll be saved." The play then concludes with the characters' resolution to move on. "Well? Shall we go?" asks one; "Yes, let's go," says another. Beckett ends the play with this line: "They do not move" (p. 61).

To use Beckett's play as a metaphor, those of us in teacher education who are convinced that technology can play a significant role in fixing education are players on a corner of a stage. We are the characters who feel that something is missing in the educational process and that something important is about to happen. We have developed programs and options that would animate the teaching of much of the curriculum of the public schools. To bridge our contributions to the general curriculum is the sticking point. We end up talking to one another in a remote drama, all the time lamenting the fact that nothing is happening. Yet we have a faith that change will occur when they, our colleagues, and the public school teachers, wake up to the enormous potential of technology. They are our Godot!

As we wait on one corner of the stage, on another corner, wait the children. Toffler (1991), Keyes (1991), and others have pointed out that technology is commonplace among the children entering our schools. Most children come to school already having had intimate involvement with video games and television, and many with computers. They will enter school feeling comfortable with technology and will expect to use it in learning.

If these expectations are to be met, someone has to act. We can either wait for Godot, or we can become proactive. We have waited for Godot and his arrival is, at best, unsure. How can we take the proactive role in this drama? Three major ideas follow:

First, we can model the use of technology in our own courses. There still lingers, even among ourselves, the tendency to teach as we were taught. We are reluctant to experiment and take risks in our own classrooms and labs. This is partly due to the pressure we feel from our colleagues to teach as they do, and partly because of our newness as an academic discipline. If we choose to play it safe, no change will occur. If we try new and creative ideas for harnessing the power of technology in teaching and learning, we can model change for prospective educators.

Second, we can invite our colleagues in methods and curriculum into a dialogue about the application of technology to skills and subject areas. Our colleagues will be enticed to visit our labs and we, in turn, will take our ideas to their classrooms. The purpose will be to infuse technology into the entire curriculum. Our colleagues will share with us their specialties, and together we can work on increasing educational options.

Third, we can take our ideas out to the schools where they can be shared with, and tested by, practicing teachers. These teachers are busy; they work with limited resources, and they are skeptical of quick-fix propaganda. We should assume they are all from Missouri; we have to show them. Nothing will jumpstart change faster than a convincing demonstration.

As we learned from Beckett's play, Godot will probably never arrive. We may sit on the stage and talk with one another, or take action and advance our ideas where they are critically needed. When we choose the latter, we become change agents, and we will play an active role in fixing education.

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Conceptual Framework for Incorporating the Learner into the Technology Environment

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Abstract

Educators are searching for a conceptual framework for incorporating learners into the technology environment. To embark on such a mission requires giving careful consideration to the many variables that enter into the learning and teaching environment. A conceptual model for incorporating the learner into the technology environment (ILTE) is proposed. Factors of the model are the student, the teacher, human wants and needs, and technology. These factors must be viewed as the structural components that maintain the stability of relations in the technology environment. The dynamics of the model are maintained by interaction, society, and exposure. These are the processes whose major responsibility is to transfer information among the various components of the technology environment.

Introduction

Educators are searching for a conceptual framework for incorporating learners into the technology environment. To embark on such a mission requires giving careful consideration to the many variables that enter into the learning and teaching environment. A conceptual model for incorporating the learner into the technology environment (ILTE) is proposed. Factors of the model are the student, the teacher, human wants and needs, and technology. These factors must be viewed as the structural components that maintain the stability of relations in the technology environment. The dynamics of the model are maintained by interaction, society, and exposure. These are the processes whose major responsibility is to transfer information among the various components of the technology environment. Details of these elements are discussed below (see figure 1).

There is a need for a conceptual framework for incorporating the learner into the technology environment. The practitioner needs a base for structuring instruction, creating the learning environment, developing a philosophy of learning, and developing instructional theory.

Factors of the ILTE model

Student

Technology acts on the student's intellect and intuition to stimulate thinking and processing capabilities (see figure 2). The student is teachable and can learn. The technology environment must provide the learner with the resources and strategies to learn and acquire knowledge. Montague' (1988) suggests that instructional environments should give the learner the context in which what is learned will be useful. This utilitarian view about education lends support to the belief that technology education must equip the student with tools for survival. Chirwa (1991) notes that software developed to fit the characteris-

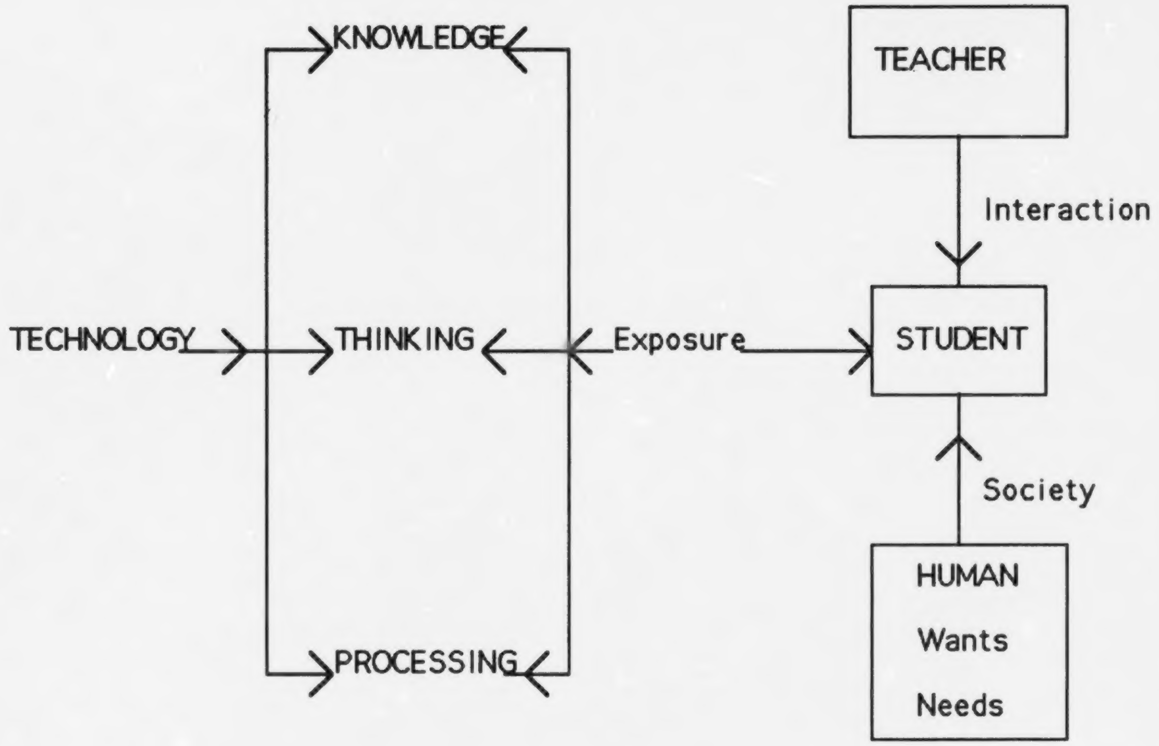

Figure 1.
Conceptual Framework For Incorporating Learner into the Technology Environment

tics of the students enhances the acquisition and retention of concepts in mathematics.

Incorporating the learner into the technology environment with the student as the basis for learning can be achieved through the following:

a) defining the learning environment with respect to the availability of materials,
b) selecting materials that match the needs of the student,
c) providing the learner with a competent and knowledgeable teacher.

Teacher

The teacher should have the knowledge and skills to competently impart knowledge to the learners and guide them through difficult learning events.

Instructional theorists claim that the analysis of content within a knowledge domain leads to an understanding of the technology environment and an increase in the knowledge base (Riegeluth, Merrill, and Bunderson, 1978). Millaward (1980) observed that the sequencing of conceptual networks into higher order knowledge structures and the creation of new conceptual networks are contributing factors to the development of the knowledge of the teacher. Effective teaching and communication results from a well defined knowledge base. Technology can facilitate the development of this knowledge base for teachers.

Incorporating the learner into the technology environment with a teacher capable of stimulating learning can be achieved in the following ways:

a) have the teacher determine the levels students are functioning at,
b) have the teacher explore and determine the nature and prior knowledge of students,
c) adapt learning material to the special needs of the students,
d) center teaching strategies on challenging students' cognitive styles,
e) incorporate motivational strategies into courseware.

STUDENT
* Determination
* Doing
* Intuition
* Intellect

TEACHER
* Knowledge Base
* Competence

HUMAN WANTS AND NEEDS
* Individual
* Values
* Survival

TECHNOLOGY
* KNOWLEDGE
* Thinking
* Processing

Factors of the ILTE Model

Figure 2.
Factors of the ILTE showing the structures:
student, teacher, human wants and needs, technology

Human Wants and Needs

In every civilization individuals' values are expressed through technology. The goals of technology education is to educate for value, identity, and cultural understanding. Man has endowed technology to serve as the instrument to bridge the communication gap between people of different beliefs.

Instructional designs theories must consider the needs of the society and the individual. Ross and Ralow (1982) recommend that to enlarge students' understanding microcomputer environments should be adapted to their needs.

Incorporating the learner into the technology environment with human wants and needs as a basis for structuring teaching and learning can be achieved in the following ways:

a) examine human wants and needs,
b) select values that can be addressed with available resources,
c) engage students in experimenting with various societal values,
d) select learning materials that enhance self-esteem and create motivational factors,
e) create learning environment that give students a sense of belonging.

Technology

Technology incorporates knowledge, thinking, and processing. White (1968) postulates that technology has a greater influence on science than science has on technology. Schmookler (1966) demonstrated in a study examining 934 inventions that technological advances were a result of value judgments and preceded scientific discovery. To the enlightened teacher technology can be used for advancing instruction and creating new horizons for discovering new ways of survival. Technology is a value system that has an impact on society.

INTERACTION
* Message -------instruction
* Reaction ------learning

SOCIETY
* Demands ----------basic skills
  ----------high order skills
* Promoting ----- next stage
* Stagnation -- --- unaccomplished

EXPOSURE
* Technological tools
* Learning and Teaching material
* Audience

Dynamics of ILTE Model

Figure 3.
Dynamics of the ILTE showing the elements : interaction, society, and exposure

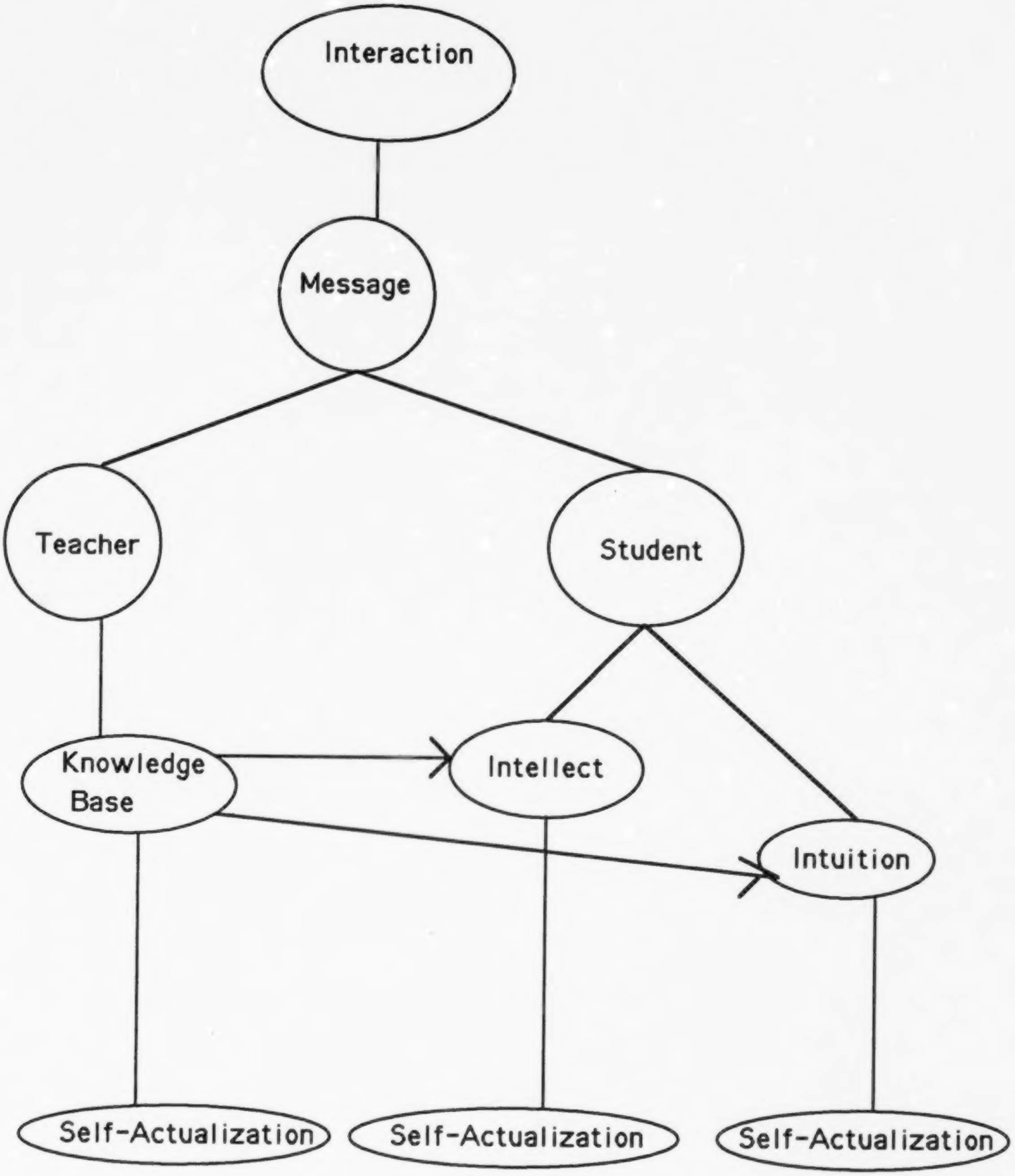

Figure 4.
Technology and Interaction in achieving self-actualization

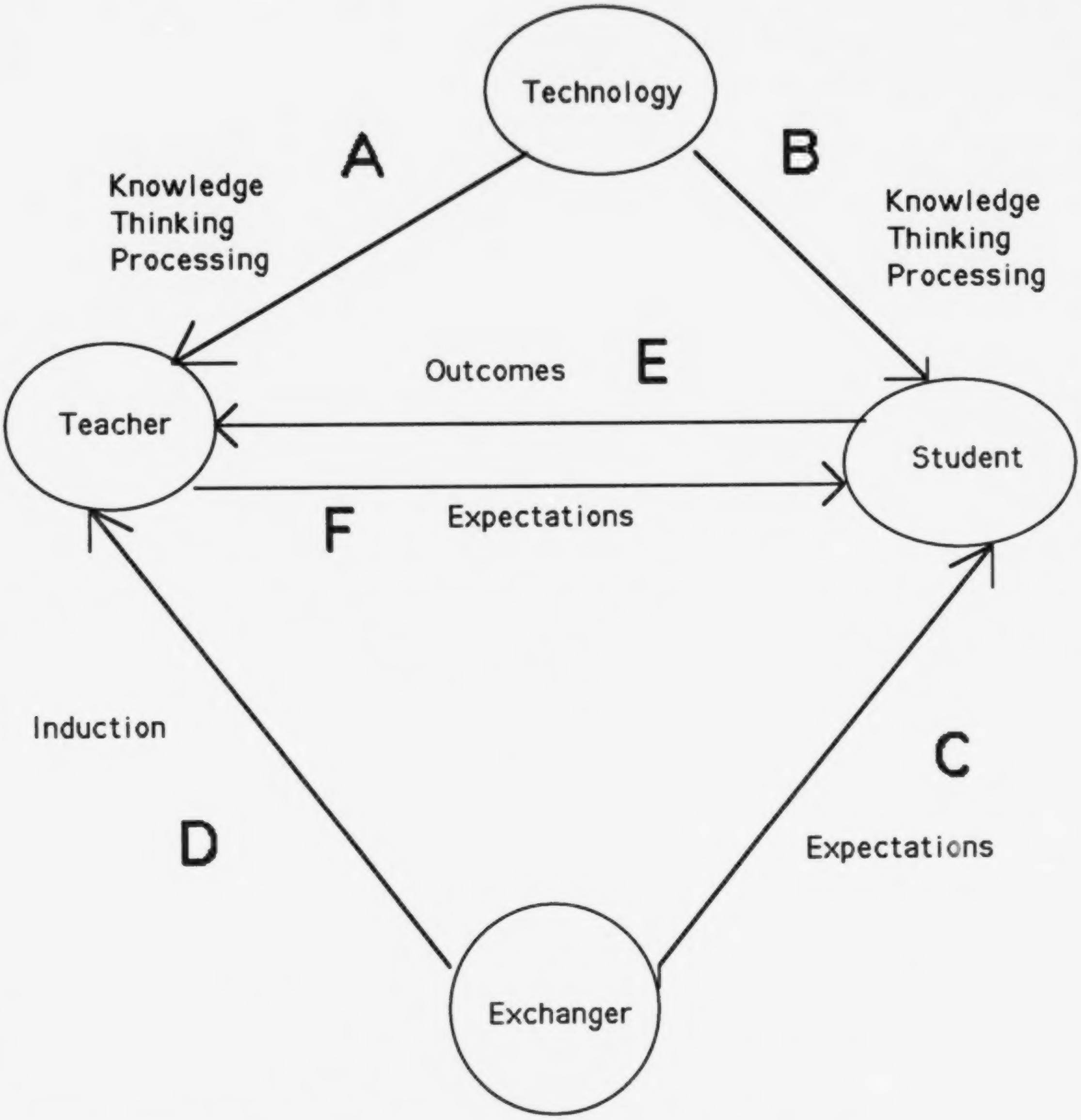

Figure 5.
The "Boat" influencing interaction between student, teacher, and society in the technology environment leading to self-actualization

Incorporating the learner into the technology environment with technology as the basis for learning, development, and growth can be facilitated in the following ways:

a) determine the objectives to be achieved,
b) select instructional materials that are adapted to the needs of the learner,
c) search the basis for technology,
d) select an instructional theory,
e) develop instructional strategies.

Dynamics of ILTE model

The dynamics of the ILTE model are governed by interaction, society, and exposure (see figure. 3). The role of these elements in the dynamics of incorporating the learner into the technology environment will now be discussed.

Interaction

Interaction is the first process influencing the exchange of messages between students and teachers. The influence of technology and interaction on achieving self-actualization is depicted in figure 4. By utilizing a well defined knowledge base to deliver instruction, the teacher stimulates the intellect and intuition of learners. This results in development, growth, and self-actualization. During interaction, the teacher and student exchange beliefs and learn how to accommodate one another.

The process of interaction proceeds in a direction that forms a "Boat," as depicted in figure 5. Structurally, technology and exchanger are located at the ends of the boat and student and teacher are located in the middle. The exchanger is the society and its values. Events originating at both ends of the boat are directed toward the teacher and the student. Between teacher and student a feedback loop is created. The exchanger induces the teacher to tap resources among students in an attempt to achieve learning. Technology activates the intellect and intuition of the learners to enable them to acquire knowledge and to process learning material.

A close examination of the "Boat" shows the direction of events. The events are focused and occur at points A, B, C, D, E, and F. At point A, technology introduces knowledge, thinking, and processing capabilities to the teacher who, in turn, influences learning and the growth of a well defined knowledge base. At point B, technology stimulates the learner's intellect and intuition which, in turn, enhances their knowledge, thinking, and processing capabilities. At point C, the exchanger forces the learner to meet expectations that translate into learning outcomes. At point D, the exchanger induces the teacher to plan suitable strategies to deliver and evaluate instruction and learning. At point E and F, learning outcomes and expectations are assessed by the teacher, student, and society via a feedback loop. The absence of the feedback loop leads to loss of learning in the technology environment.

The "Boat" has implications for instructional design, curriculum development, and program implementation and evaluation. When assessing learning outcomes certain prerequisites must be taken into account. First, define the learner. Second, select learning materials that fit into the learning styles of the student. Stages of instruction can be structured differentially for each part of the learning outcome by examining the external and internal processes that affect a student during learning. Some educators advise on the value of understanding the underlying processes that may influence learning (Estes 1978, Klatzky 1980). Gagne' and Wager (1988) recommend dividing learning outcomes into intellectual skills, verbal information, motor skills, and attitudes.

In the ILTE model learning outcomes are grouped into societal skills, intellectual skills, intuitive skills, and motor skills. Societal skills are attitudes. These are a property of the emotion. Intellectual skills are thinking and processing capabilities. These are a property of the intellect. Intuitive skills are creation, invention, investigation, and judging capabilities. These are a property of the intuition. Motor skills are physical and mental maturation. These are a property of the body and the mind. The teacher must assess learning outcomes using both formative and summative evaluation techniques.

The goals and objectives of a technology program should be well defined to facilitate the development and acquisition of learning and teaching materials. Technology materials must be structured to promote student learning, the development of new skills, and aid the teacher in imparting knowledge. Instructional design issues focusing on user control of learning (Keller and Suzuki 1988, Malone 1981) support the need of structuring teaching and learning materials to stimulate and motivate student learning and to give them a sense of satisfaction with learning experiences.

Society

Society is the second process by which communication between the student and the teacher is influenced in the technology environment.

Society is the demander, promoter, and stagnater. Figure 6 depicts the interaction of technology and society in facilitating self-actualization. As a demander, society dictates what needs must be met to satisfy the quest for survival and self- actualization. As a promoter, society dictates skills that must be acquired to ensure survival and self-actualization. As the stagnater, society presents man with reality and problems. Reality is the ability to deal with knowledge of the environment. Problems are society's signals for taking action in meeting human needs and wants. The individual must attain a level of

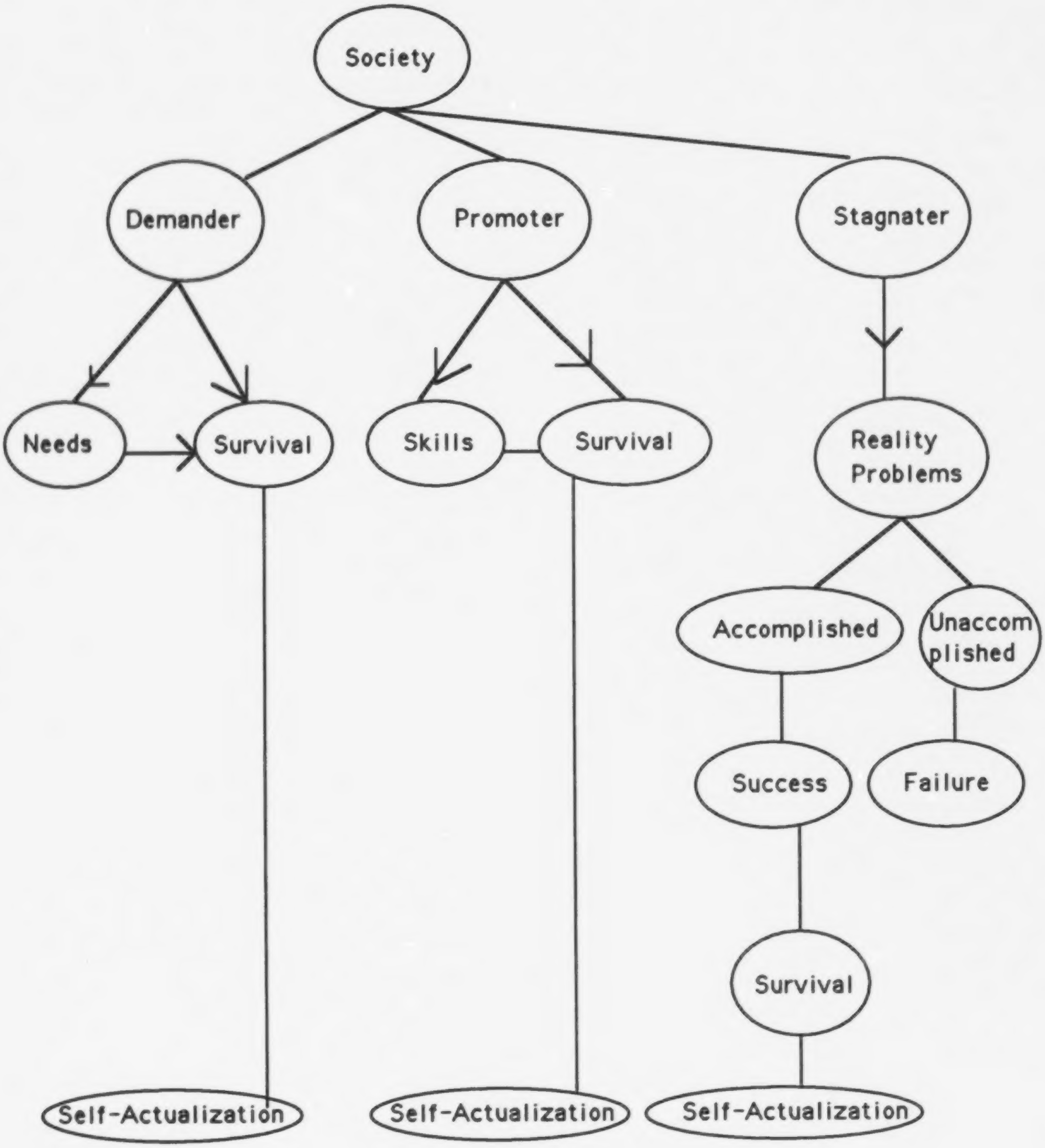

Figure 6.
Interaction of Technology and Society in achieving self-actualization

competence in basic and higher order skills to accomplish success in achieving survival and self-actualization. An individual who does not have skills becomes unaccomplished and a failure.

The role of technology education is to train for acquisition of basic and higher order skills. Serving in the capacity of facilitator and a resource technology must provide knowledge, thinking, and processing capabilities that can be tapped by both the teacher and student to advance development and growth.

Society is the process of linking the learner to the technology via values. This process proceeds in a "Reflective Loop" as depicted in figure 7. A close examination of this reflective loop shows that technology sends rays of information to demander, promoter, and stagnater. These societal structures, in turn, cast the rays of information on the learner. A feedback loop is created between the learner and technology. Rays of information are constantly transmitted through this feedback loop to ensure communication between learner and the technology.

The way a learner handles these rays of information in the reflective loop depends on three factors: (1) learner's characteristics, (2) nature of material, (3) teacher's awareness. Learner's characteristics is defined as prior knowledge, mental maturity, and motivation. The nature of material is defined as the level of flexibility of content through which learners process and acquire knowledge and skills. Teacher's awareness is defined as the level of competence with which instruction is delivered and a conducive learning and teaching environment is created. These factors must be coordinated by society to facilitate communication.

The "Reflective Loop" of interaction between technology, society, and the student has implications for instructional design, creation of the learning environment, and program development and evaluation. The technology environment prepares both teacher and student to acquire basic and higher order skills through five stages: (a) presentation, (b) accommodation, (c) engagement, (d) selection, and (e) confirmation. At the presentation stage components and function of the skill are presented. At the accommodation stage time is allowed to examine and to experiment with the components of the skills. At the engagement stage learning material are evaluated and the decision is made as to where they fit into cognitive and affective styles. At the selection stage a choice is made about the features of learning that are beneficial for development and growth. At the confirmation stage evaluation of learning is completed.

Technology systems and materials must support society's development of tools to facilitate man's need for survival. Incorporating motivating features in courseware can stimulate interest in learning. Intelligent systems must be interactive and must allow some student control of learning in order to promote independence and the development of critical thinking skills. Instructional design theories must promote the creation of learning environments in which learners feel that their expectations are met. This generates confidence and satisfaction among learners and fosters an appreciation of learning. Keller and Suzuki (1988) note that evaluation and feedback methods incorporated into courseware aid the learner in building internal attributions of success, develops confidence, and increases self-esteem. Tennyson and Christensen (1988) describe an intelligent system, MAIS, capable of dialoguing with the learner. By interacting with such a system the learner's cognitive powers can develop because the system combines both learning theory and instructional theory to direct its learning and teaching environment.

Exposure

Exposure is the third process that facilitates communication between teacher and student. The influence of technology and exposure on achieving self-actualization is depicted in figure 8. The learner comes in contact with the technology tools. Cognitive and affective domains of learning experience growth only when the learner interacts with the technology. Effective growth results in self-actualization.

Exposure is the process of linking the learner to technology tools and to learning and teaching materials. The process proceeds in a cyclic pathway as depicted in figure 9. A close examination of the cyclic pathway shows the direction of events that govern the linking. The events are interactive and occur at points A, B, C, D, and E. At point A, technology facilitates the development and growth of intellect and intuition to empower the learner with knowledge to develop thinking processing skills. At point B, the motivated learner and competent teacher create a technology environment that is conducive to teaching, learning, development, and growth. At point C, the teacher experiments with human wants and needs and makes discoveries that elevate knowledge and consciousness and bridges awareness with the environment. Such knowledge is, in turn, shared with the learner. At point D, human wants and needs translate into values that technology must maintain by signaling the learner with a message to maintain "survival" and to develop survival skills. At point E, human wants and needs force the learner to develop survival skills.

The cyclic pathway has implications for instructional design, planning, and program development in the technology environment. When planning to expose the learner to technology the educator must be aware of the interactive nature of this pathway. The intellect and intuition need to be developed in learners via instructional

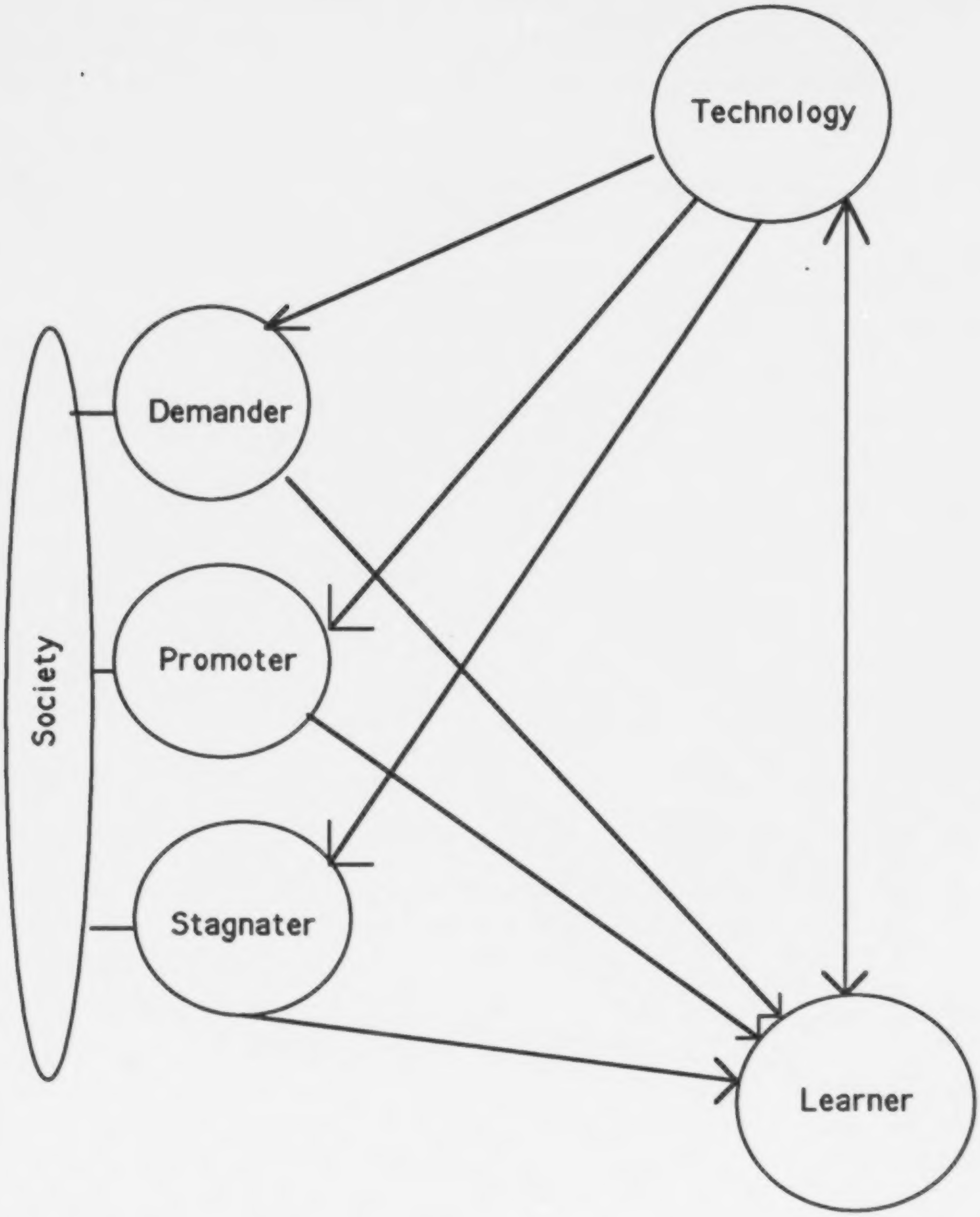

Figure 7.
Reflective Loop between technology, society and learner in influencing self-actualization

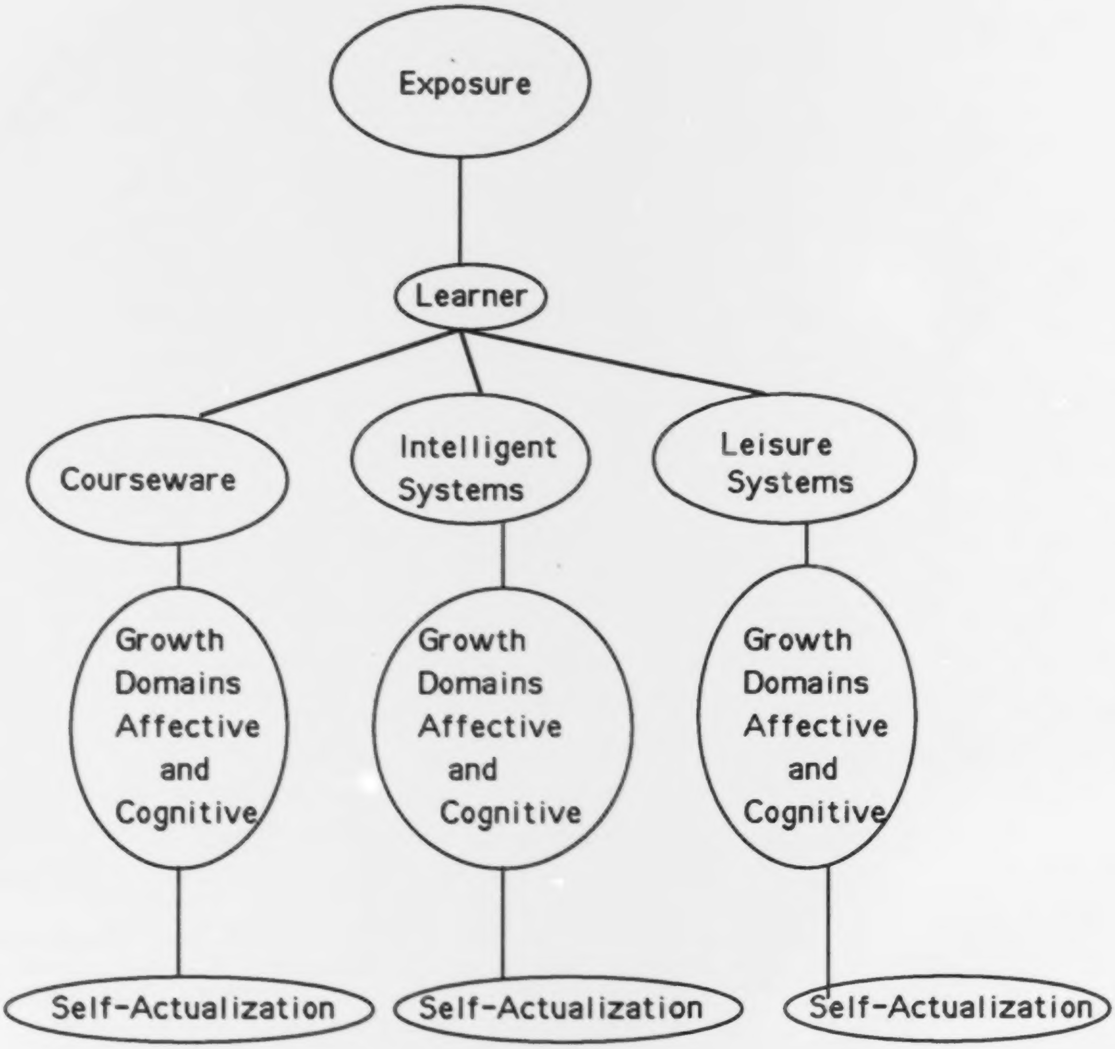
Exposure
Learner
Courseware
Intelligent Systems
Leisure Systems
Growth Domains Affective and Cognitive
Growth Domains Affective and Cognitive
Growth Domains Affective and Cognitive
Self-Actualization
Self-Actualization
Self-Actualization

Figure 8.
Technology influence in achieving self-actualization

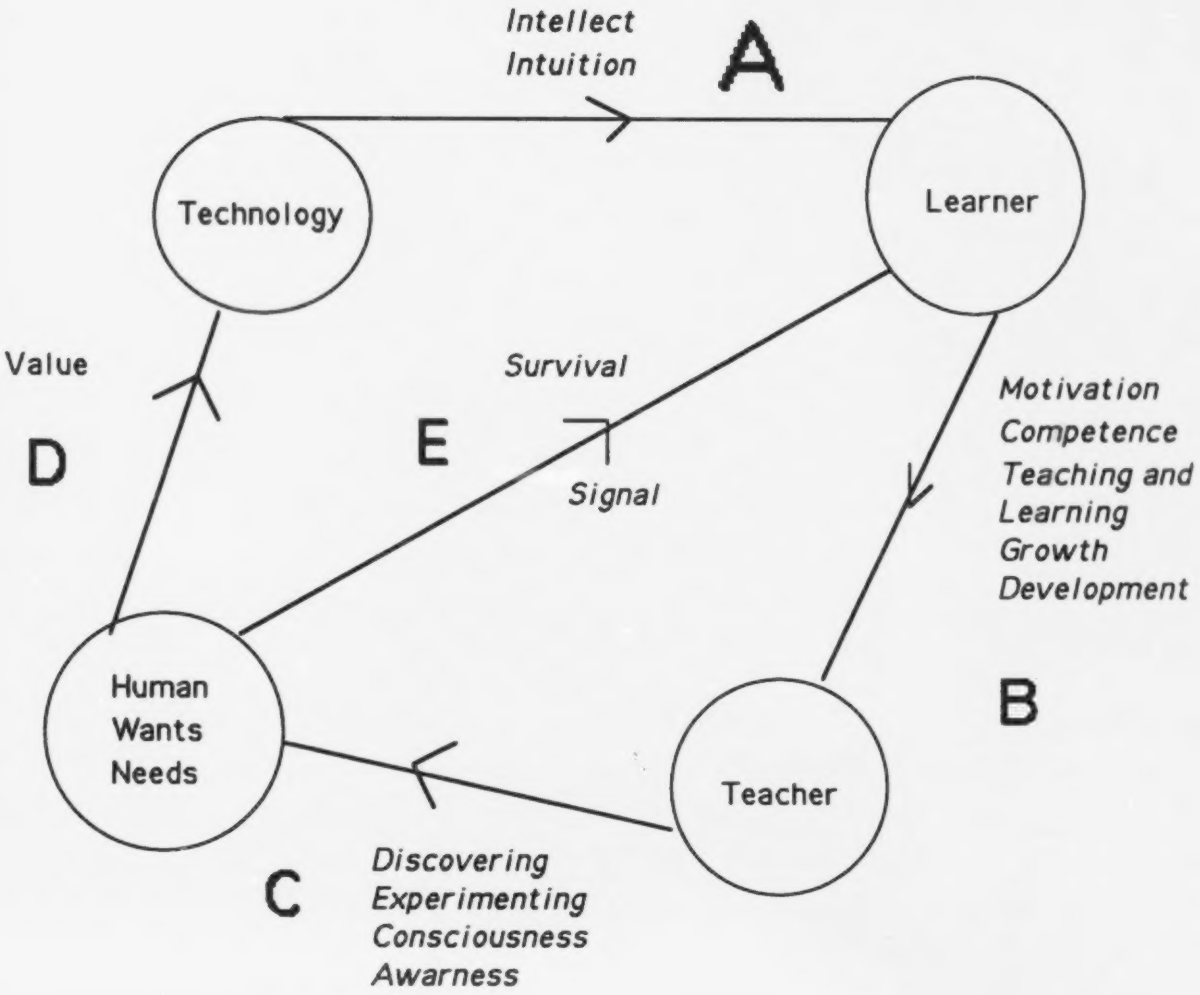

Figure 9.
Cyclic Pathway Influencing the linking of the student to the Technolgy

theories that promote learning and via teaching strategies centered around the learner and teacher. Learning and teaching strategies need to be efficient to enable the learner and teacher to process information and to deal with complex ideas. Learning material should incorporate learning strategies. Learners should be encouraged to develop their own strategies in dealing with materials. Teachers must be provided with tools to assess educational outcomes and the growth of learners. Content material in the courseware should be followed by well defined learning and teaching objectives.

Intelligent systems should be interactive. Leisure systems should combine play and learning by embedding motivational features into the material. Material must contain features that recognize individual differences among learners and allow for control of the learning environment. Cronbach (1957) encourages educators to consider combining knowledge from correlational research on individual difference with the search for meaningful teaching methods to accommodate a broad spectrum of learners. Hannafin (1984) identifies internal control as the means by which the learner controls learning events by utilizing features embedded into instruction by the designer. Malone (1981) and Banet (1979) recognize the value of games in activating motivation to learn. Tennyson and Park (1986) recommend that intelligent systems be holistic and inferential to improve individual learning.

Recommendations

The concepts of boat, cyclic pathway, and reflective loop have been introduced as structures in the dynamics of incorporating the learner into the technology environment. This model leads to the recommendation that teachers may consider structuring teaching and learning events as dynamic components in the acquisition of knowledge and the development of skills. The "Boat" offers instructional designers a base on which to create educational goals and objectives during curriculum development. The "Reflective Loop" offers the teachers, designers, and evaluators a framework for thinking about how societal values influence the integration of knowledge and skills. Learning and teaching strategies can focus on how society influences both the learner and the technology. The "Cyclic Pathway" offers the society, the teacher, and the student a way to integrate human potential into the development of new values that sustain the vitality of society. Educational goals must continue to promote the stability of society. Teaching and learning strategies must enhance the efficient delivery of instruction and the acquisition of knowledge and the development of skills.

The concepts of the ILTE model focus on society, human wants and needs, technology, students, and teachers. Educators can shape these concepts as they reflect on curriculum development, instructional theories, philosophy of education, learning and teaching strategies, conducive teaching and learning environments, and the development and evaluation of programs.

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Linking LAN Writing and Group Leadership: A Preservice Laboratory Approach

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Abstract

Local area networks (LAN) and group software have inherent social dimensions and they both facilitate and provide a supportive context for group learning and collaborative writing to take place. Most preservice teachers do not receive any formal training in either the social nature of the LAN or the group processes and behaviors that naturally evolve and take place on them. Since the social behavior of students in networked writing classes is a function of their being in a networked environment and social forum, it is important that preservice teachers receive laboratory training in the nature and nurture of small leadership and development. This paper discusses the nature of small group learning and the changing role of the teacher in this electronic learning context. It then provides a rationale for the LAN laboratory and an overview of the skills preservice teachers can acquire through this instructional approach. The paper concludes with a description of a curriculum-related staff development model for its implementation.

The Electronic Learning Context

The teacher's world, the classroom, is a unique world of its own. As Doyle notes, there are six features that make a classroom the unique, complex, and potentially unstable environment that it is. These features are multidimensionality, simultaneity, immediacy, unpredictability, publicness, and history (Doyle, 1986). These features are even more extreme in the computer-networked classroom, because the network and the interactive writing software create a complex type of social forum in which students can enter a group, experience group process dynamics, and engage in social discourse without ever having encountered another human being in face-to-face interaction.

Such forums provide a supportive context for group learning and collaborative writing to take place. At the same time, they challenge the traditional view of leadership that most individuals are exposed to in formal education. In the computer-networked classroom, students do not absorb and regurgitate content, as is the case in most school classrooms. Quite the contrary, in these unique social forums, the onus for learning is on the student. While there is a great deal of structure in these environments and the teacher is present, the structure is very open and the role of the teacher is at wide variance from our typical expectations about what a leader in a teacher-learning situation does. Instead of being a didactic conveyor of knowledge, the teacher's role is to establish a collaborative helping relationship with his or her students.

Understanding the Nature of Small Group Leadership

Developing such a relationship in these networked environments, as in any small group, involves sharing responsibility for leadership with the students. In small groups, leadership represents the function of the group, especially its primary task (Rioch, 1975). The task is that which the group must perform in order to survive (Rice, 1963; Rice, 1965). Each member contributes to the life of the group in the manner in which they "lead" it on to the completion of the task or relate to the task. The various ways that the members relate to the task are ways the teacher can understand the function of the group as a whole. What are some of the ways that members of a group relate to a task? According to Margaret Rioch (1975), there are a number of questions you can ask to determine this:

1) Do they accomplish parts that, when put together, complete the entire task?
2) Do they fight to destroy it, betray it, sabotage it, work toward redefining or changing it?
3) Do they compete for position of leader?
4) How do they conceive of authority in the group?

Underlying these task-related behaviors are emotional needs that may have little or nothing to do with the actual task or learning. The real problem for every group, then, is to recognize these unconscious needs and to become capable of mobilizing the one that was most appropriate for the task they were meant to perform (Richardson, 1975).

Small Group Leadership: The Teacher's Role

In a local area network environment, the development of a more responsible leadership and followership in group life entails effective management. Teachers need to be able to recognize a group's needs, to help the group discover the most appropriate means of relating to the task, and to guide them through the task in a unobtrusive manner. In short, it requires that teachers encourage shared leadership without relinquishing their own authority or "control." This is a difficult balance for most experienced teachers to achieve and one that would be of great concern to preservice teachers — a concern beyond the already difficult responsibilities of group instruction, word processing instruction, writing instruction, and network pedagogy and management. Preservice teachers are, therefore, going to want to know how to take the necessary steps to ensure that the students they teach will be both attentive and not disruptive (Glatthorn, 1990).

Rationale For A Preservice Laboratory Approach

When we consider what would be the appropriate training for preservice writing teachers, we have to anticipate a variety of instructional skills and competencies. Not only will writing teachers have to become skilled in collaborative writing pedagogy, they will also have to become proficient in the nature and nurture of small group dynamics and development. This will involve learning and practicing the structureless leadership skills that are at the heart of this new learning dimension, the computer network. How can this training best be carried out? The best experience that preservice teachers can receive is hands-on laboratory training of these skills in an LAN writing environment. Why a laboratory? The methodology of a laboratory is to create, "...for the purposes of analysis and practice, group situations where the same basic factors of individual and group relations are present..." (Bradford, 1953, p. 14). Thus, a hands-on LAN laboratory can present preservice teachers with an analogue of the group writing situations that, no doubt, they will confront in their own networked writing classroom.

Bennis (1962) has suggested that an important goal of all laboratory training is the expansion of a collaborative view of authority relations. If we conceive of this LAN laboratory as a means of creating social writing dilemmas emphasizing this goal, then we can provide preservice teachers with the opportunity to gain valuable insights about the nature of shared authority first hand by resolving and analyzing dilemmas. In the LAN laboratory, these insights will be even more valuable to the preservice teacher, because they will flow both from the experience itself and from the way the experience is processed within the laboratory training.

Overview of the Skills Learned

In designing the curriculum for an LAN laboratory, the focus of the learning is on both the social nature of the LAN and on the group processes and behaviors that naturally evolve and take place on them. Social writing dilemmas allow teacher trainers to effectively emphasize both of these goals. By analyzing and articulating on the LAN the authority issue in the social writing dilemma, preservice teachers learn collective problem-solving and sharing. When they receive instruction in this laboratory context, preservice teachers have the opportunity to learn how to learn through an inductive orientation (what is to be learned is not necessarily clear); they have the opportunity to be a teacher (any member can be a teacher in a group situation); and they have the opportunity to understand the processes and behaviors that take place in a group learning situation. (The group development work of Wilfred Bion and Robert Bales serve as the theoretical basis and interactional system for teaching and observation in this lab. For a complete summary and explanation of their work see Hare, 1973.)

Suggestions for Implementation

For effective implementation of this LAN laboratory, we need to consider the use of a curriculum-related staff development model for preservice training in networked writing instruction. These implementation-oriented models are tied closely to a planned or implemented curricular change (such as the introduction of networked instruction). Commonly, such a program is intended to support the implementation and "is designed to help teachers understand the new curriculum, translate [it] into specific teaching plans, and to acquire the skills needed to implement [it] effectively" (Glatthorn, 1990, p. 229).

How the model is implemented will vary according to the context and teaching level; however, "the research suggests strongly that effective staff development is essential if a high level of implementation is to be achieved" (Glatthorn, 1990, p. 229). In addition, such experts as Hall (1978) believe that these implementation-oriented programs will be more effective if they are sensitive to teacher's stages of concern. In his summary of Hall's work on staff development

(1978), Glatthorn explains that when people are "confronted with a proposed innovation, they tend to move through seven stages of concern about the innovation" (1990, p. 229). (Below is a paraphrase of Glatthorn's representation of Hall's work.)

Stage:	**Level of Concern:**
Stage 0:	Awareness. At this stage teachers would have little concern about the network (and software).
Stage 1:	Informational. Here they would be interested in learning about the network.
Stage 2:	Personal. At this stage they would be concerned about the demands of the network and its personal impact.
Stage 3:	Management. Here the attention would be focused on the efficient use of the network and management concerns.
Stage 4:	Consequence. At this stage the teacher would have concerns about the impact the networks would have on students.
Stage 5:	Collaboration. Here the focus would be on the coordination and cooperation with others in using the network.
Stage 6:	Refocusing. At this last stage the teachers' focus would be on exploring general benefits of using the network and possibly modifying those uses.

During the early implementation of an innovation, such as the network, concerns felt at stages 0, 1, and 2 will be felt most intensely. As implementation progresses, concerns at stage 3 will be paramount, and at the end of the implementation concerns of stages 4, 5, and 6 will intensify (Glatthorn, 1990). For this reason, teacher trainers need to continually reflect upon and respond to these changing concerns.

An LAN laboratory approach offers numerous advantages for teacher training in group leadership skills. It is one way that we can begin to demystify the network technology and the process of group learning. As the LAN lab progresses and its members become better able to handle the group's emotional needs, preservice teachers can learn first hand that leadership can be exercised in many different ways and by many different individuals. Understanding this can help teachers to be able to make more effective use of the computer network in their classroom, because it represents a much more effective way of changing the way teachers teach (or will teach). It begins by giving them the tools and skills and helping them become users.

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Metacognition in Computer-Assisted Language Learning (CALL)

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Abstract

To date numerous conceptualizations of the role of the computer in language learning have been suggested. The Felicitous tool, the magister/pedagogue, the proteus of machines, the partner/tutee/ adviser, the stimulus/knower-of-the-right-answer/ workhorse, and the computer-as-a-library are examples of these conceptualizations. The metaphors used to conceptualize computer roles may be seen as cognitive systems (in the sense of Lakoff and Johnson's *Metaphors we live by).* They function to capture, structure, and give coherence to the variables of language, learning, and teaching operational in different computer-assisted language learning contexts. In this paper, this metacognitive activity and its relevance as praxis in teacher education programs is examined and made explicit.

Introduction

In *Metaphors we live by*, Lakoff and Johnson (1980) demonstrate how metaphors are not just ways of talking about things they correspond to ways of thinking. They argue, for example, that the metaphor "Time is money" is not only the way we talk *about* time it *is* the way we conceive of time. Further, the authors point out that metaphors carry their own blindness. Thus, for example, with "Time is money" and our "budgeting efforts" there is a blindness to time as life. In the following I look at some conceptualizations of the role of the computer suggested to date in computer-assisted language learning (CALL).

Conceptualizations of the role of the computer

The Felicitous tool (Cochran-Smith, Kahn and Paris, 1990), the partner/tutee/adviser (Ng and Olivier, 1987), The Proteus of Machines (Papert, 1980), the magister/pedagogue (Higgins, 1988), the computer as audience and stylus (Daiute, 1983), the computer as a library (Barlow, 1987), the computer independent and dependent variable (Rubin and Bruce, 1990; Michaels, 1990), the computer as stimulus/knower-of-the-right-answer/workhorse (Jones and Fortescue, 1987) are some examples of the metaphors used to conceptualize the role of the computer in computer-assisted language learning (CALL). These function as cognitive devices to structure and organize different assumptions about language, learning, teaching, and the design features of the programs that mirror these variable perspectives in the CALL context.

The following table identifies for each of the metaphors the overt experience that is being structured. I have divided this experience into two categories: the CALL context and the application.

As creators of metaphors, scholars give coherence and harmony to both their theoretical background and the praxis they engage in. These cognitive "pegs," in turn, give rise to critical responses in the literature and some-

Conceptualizations	CALL context	Applications
The Felicitous tool	K-beginning writing English first language	word processing
The audience/stylus	beginning writers English first language	word processing
Dep./indep. variable	6th grade, upper element and middle school.	The QUILL (a word processor, e-mail, story prompt, database combination)
The Proteus of machines	k-12 computer science	LOGO
The Stimulus	ESL	games, simulations
The Knower-of -the	ESL	tutorials, drill & right-answer practice
The Workhorse	ESL	word-processing data bases
The Magister	All levels. English first and second language learning	Programmed learning- Intelligent tutorials
The Pedagogue	All levels	Cloze programs, text gameprograms, simulations
The Library	Academic-ESL	Mainframe/PC
Partner/Tutee/Adviser	First and second language learning All levels, various languages in Canada, USA, and Britain.	LOGO (tutee) Simulations(partner) Intelligent tutors (Adviser)

times they open up the way for new explorations and insights. Critiques tap the blindness built into the metaphorical system. Thus, for example, one theoretical response generated by the use of Logo and the Piagetian theory of learning used as its pedagogical rational is borrowed from Soviet Activity theory (e.g.,Leont'ev 1981; Wertsch 1981). Emihovich (1990) argues, for example, that in the design of Logo and its use, the importance of collaboration and inter-actions are undermined by tapping into the blindness of a metaphor that ascribes magical properties to the machine at the expense of the fundamentally human property of communication. Conversely, the Protean metaphor may be used for new explorations as it provides a framework for the study of computers as distinct from other closed-system technologies.

An alternative conceptualization

Looking at the role of computers in CALL, I have been working with the notions of *instrumentality* and *agentivity,* in particular for the learning and teaching of French as a foreign language (Herrmann, 1990). In this conceptualization, however, an underlying experience was structured which asserts the fundamental difference between human agents and their tools (i.e., extensions, Engels, 1940 quoted in Wertsch, 1981 and Leont'ev, 1981). Thus, while there exists a design tradition in CALL that is both anthropomorphic and progenitive (extrapolated from Dretske, 1985; Winograd and Flores, 1986) corresponding to such applications as Tutors, DrillMasters and TaskMasters, there also exists an instrumental tradition corresponding to such applications as word processors, communication networks, and data bases and their potential to both support and create collaborative activity systems among the members of a classroom community.

Relevance of metacognitive activity

The relevance of metacognitive activity (as in "thinking about thinking", the term is from Emihovich, 1990) for teacher education programs is threefold. First, this activity leads to an understanding of some of the forces operational in the design of computer technology. Secondly, as a purely intellectual activity it provides a framework for the constructive critique of current designs and their application in the classroom context. Finally, it is hoped that, in turn, such an activity can be integrated and transformed through discussion into innovative designs and uses.

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Technology in Schools: Repetition or Transfer?

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Abstract

A qualitative study being conducted in schools in western Michigan is designed to discover the primary technology implementation pattern of each school: Repetition or Transfer. In preliminary results one can see that each of the implementation patterns is not exclusive to a school situation. Teaching methods that support transfer were found to be related only to teacher variables: background knowledge and vision about the student target stage. Implications are drawn to teacher education in technology and to teacher education in general.

Transfer—An Essential Component in Computer Literacy

The process of educating teachers for computer literacy starts in schools of education where preservice or inservice courses introduce novices to a new field. Some courses capitalize on mastery of particular programs while others stress nonverbatim concept acquisition (Javetz, 1991). Typically, courses with general comprehension and transfer goals employ different teaching methods (Budin, 1991; Javetz, 1991; Galloway, 1991). These teaching methods have a twofold objective: to have the teachers deeply assimilate the concepts and to have the teachers transfer the methods and goals to their own work environment. In a sense, successfully completing a paper and pencil test does not prove that the teacher training was successful unless new knowledge is transferred or applied in a school situation where students are experiencing success with technology.

One more outside influence on schools is curricula written by powerful institutions like State Boards of Education. Computer and related technology might be treated separately with a set of goals or might be incorporated within goals concerning "Technology," a new subject matter, which focuses on problem solving via technological solutions. The following objectives, reflecting high aspirations, are mentioned in a Michigan document:

Elementary Level:

1. Describe how technology meets human needs in the home, school community, and workplace.

Middle/Junior High Level:

1. Analyze interrelationship among technologies.
5. Articulate that computers are tools for information processing, communication, expression, decision-making, problem solving, and control of other devices.
7. Describe available information technologies, their functions and capabilities.

High School Level:

2. Describe why technology can be viewed as a tool to be

> used for the development, enhancement, and encouragement of other human skills. (Michigan State Board of Education, 1991, p. 12).

It is also true that lower expectations are also formulated by school districts (Schuttenberg, McArdle, & Kaczala, 1985).

In order for K-12 students to operate on the level designated in the objectives they should be provided with a deep understanding of concepts and software so they would be able to generalize to similar phenomena (e.g., other word processing programs) and later transfer to a variety of products and uses (different types of programs, CD-ROM, or videodisc). On this issue, generalization and transfer, the literature is in agreement that transfer does not occur unless it is specifically taught and supported by certain teaching methods and types of prerequisite knowledge (Carnine, Kameenui, & Maggs, 1982; Delclos, Littlefield, & Bransford, 1985; McGrath, 1990; Merton, 1983; Pankratius, 1990; Perkins & Salomon, 1988; Perkins & Simmons, 1988; Salomon, 1984; Salomon & Perkins, 1987; Sawrey, 1990; Steinberg, 1983).

Transfer has been classified in two ways: "the high road of mindful active generalization of whatever has been learned, and the low but long road of automatic transfer of something that has been overlearned and practiced in a variety of situations" (Salomon, 1984, p. 10). Even though all agree that the high road is better (Perkins, 1991; Salomon, 1984), computer literacy can benefit from both types of transfer. Low road transfer in computer literacy enables a student to go from one word processing program to another and high road transfer manifests itself in figuring out many types of programs, input devices, etc.

Watching various institutions (including Schools of Education) reveals that some follow a *repetition* pattern in technology issues. For example, one program is partially known to secretaries who teach each other how to use it (without ever consulting the manual). The same is true for faculty. In short, the whole technology experience is limited to a very few software packages. This knowledge is transmitted to others through a procedural approach (Javetz, 1991) that does not produce comprehension so transfer cannot take place. The successful accomplishment therefore is **repetition**: use of the same program for the same function. On the other hand, some small organizations such as businesses and clubs follow a pattern of *transfer*. New hardware and software are adopted all the time so new applications are found constantly. These users have an ever growing body of knowledge which facilitates transfer.

The investigator's hypothesis has been that some schools are operating as a teaching unit dealing with technology in a pattern of repetition while other schools are dealing with technology in a pattern of transfer. For some schools, technology is one type of equipment and a mastery goal for one program. These types of activities are provided by the computer department and they do not relate to the mainstream of school activities. While in other schools, equipment and software have a higher priority. Many teachers are using technology for teaching and management and students are encouraged to explore and master more programs.

These patterns are hypothesized to influence student achievement in the short run and to determine attitudes in the area of mastery of technology products.

The Study

A qualitative study on the patterns of technology implementation was designed and implemented in schools in western Michigan. The study is being conducted by the principal investigator and two graduate assistants.

Sample

School districts from two neighboring counties were contacted by a formal letter and a follow up phone call. Most of them agreed to participate in the project.

Materials

Two lists of indicators were developed, one to reflect a state of affairs indicating a transfer pattern and one to reflect a pattern of repetition (see Table 1). Each item in both lists deals with one aspect of a school situation but the entire list of each model deals with many aspects of computer education — from hardware and software availability; through computer curriculum, teacher's philosophy, and instructional method; to computer culture and integration into the curriculum

The two lists operationalized models that were conceptualized initially as diametrically opposing each other. In addition to the two lists, semi-structured questionnaires were developed: one for the school leaders (principals and or computer coordinators), one for computer teachers, and one for students. The questionnaires were designed to clarify issues mentioned in the indicators' lists. The questionnaires were designed to touch on every aspect of school life in order to provide data that later might show a pattern. For example, is parents' involvement a contribution to a pattern of repetition or transfer? Because of so many unanswered questions, the leader's questionnaire included: personal background, school information, hardware situation, curriculum statement (from both local and state levels), description of computer education program, teaching staff for computer courses, integration into the curriculum, students' achievement and satisfaction, parents and community involvement, and future plans for computer education.

Procedure

The researcher and a trained graduate assistant visited the schools. Typically two visits were done for each school district. In the first visit the leadership was interviewed. During the second visit classes were observed and students and teachers were interviewed. Curriculum statements were also collected and student products were observed or collected. All observations and interviews were recorded on audio-tape cassettes. Cassettes were then transcribed and all texts were compared to lists of indicators. So far the following patterns have been observed.

Results

First, statement of curriculum and principals aspirations' were very similar in their level of expectation regardless of what was happening in the classrooms as the following example shows:

K-12 Core Curriculum for a middle school

Learner Outcomes

At the conclusion of this course, the student will be able to:

1. Explain differences between typewriters and word processing programs, demonstrate the ability to use a generic program, save and retrieve documents from a disk, and print. They will also be *able to identify features to look for in a word processing program.* (My emphasis—E.J.)

as compared to:

Computer Education 6-8

Program Goals
Students will
1. .....
2. .....
3. .....
4. Use the computer to solve problem within various disciplines using appropriate software such as data bases, word processing, simulations, etc. (grades 6, 7, 8).

Second, teaching procedures of extreme repetition were observed:

> Let's just do this. Let's type "t-h-e"—No, I want it small (not capitals-author). Alright? Oh, what do I want to write: Let's go back to the first "t." You need to make it a capital, so simply use the shift and retype the "t" right over the top. Then move the cursor. Oh nuts, I was going to see what your sentence was.....(Middle school teacher)

Third, teaching procedures of mild transfer were observed:

(Middle school teacher)
(Students were requested to load into RAM some file a second time).

Teacher: Where do you think the first file is—the one with your name on it?
Student: It's still floating around in there someplace.
Teacher: Yes, when you don't turn the machine off, we can always get it back.

Fourth, a new teaching procedure was observed. This type can be named product-based learning. In this model several portfolios were put on display in the classroom describing 5 or 6 "jobs." To get those jobs done one would need to use MacPaint, MacWrite, MicroSoft Works, and HyperCard. There was no step-by -step procedural instruction and the course did not rely on a single software program, therefore, a repetition model does not apply. On the other hand, students worked at an individual pace and progressed from job to job without class discussions about the tool they had learned to use or in what way it was similar or different from the next tool they would encounter. A program was presented as an objective in itself and not as an example of a general rule. Therefore, a transfer model does not apply.

Fifth, the major predictor of classrooms patterns were the interviews with the teachers. As the following examples show, teachers expressed their commitment to the curriculum and sometimes also described the learner's final development as a computer user:

Interview 1
(Middle school teacher-repetition pattern observed in class)

Question: Do you follow a written curriculum or is it your choice?

Answer: We wrote the curriculum a few years ago and that's pretty much what we follow. But it was set up by a computer committee that involved people from the middle school, the high school, and the elementary school, some administrators, the business office, and we kind of sat down and wrote up a curriculum. But the curriculum changes every year and what kids

Table 1
Indicators for the Two Models: Repetition and Transfer

Issue	**Repetition**	**Transfer**
Objectives	Specific to few	General software items capabilities
Computer Courses	1-2 courses with a general orientation	More courses with a specific orientation
Presentation pattern	Sequential: step by step	Conceptual w/ overviews & comparisons
Student assignments	Uniform	Many options permitted
Evaluation criteria	Follow teacher's directions	Creation of relevant materials
Production time	Limited to class session	Undefined total of time
Student exploration	NOT encouraged	Encouraged to discover softwarecapabilities
Student presentations	Restricted to oneprogram	Encouraged to use all available tools
Available hardware	One type only	More than one type
Hardware platform	Use same all the time	Break out to different platforms or peripherals
Software	1-3 packages are taught	More types are taught & used
Teacher modeling computer use	NOT common	Regular practice
Teacher training in technology	NOT evident	Programmed for & encouraged
Integration into the curriculum	Homework on computer NOT encouraged or required	Broadening of use is encouraged
"Live curriculum"	Asks for performing uniform tasks	Asks for transfer & broadening of use
Kids computer culture	NOT encouraged	Encouraged

remember, how much they learn from the elementary, how many of them have computers at home. (Note the argument building why NOT follow the curriculum.)

Interview 2

(Middle school teacher-transfer pattern observed in class, she is describing curriculum)

Then with 8th grade, we go into complete applications and word processing and we start using the clipboard and a few other things. We also introduce so they are aware of database management and spreadsheet applications. We look at employment in the computer field and we try to really instill in them the idea of making judgements as far as using the various applications for various tasks. (Note the emphasis on following the curriculum, and on the user as making judgements/choices rather than being a one program "prisoner.")

Sixth, the assumption that one entire model would operating within a school district proved not true. Every teacher expressed a different philosophy and different classroom practices. For example, in the same school district Y (in the high school) taught by a product-based model, A (in the middle school) taught by a weak transfer model, and N (in the elementary school) did not teach computer skills at all. N brought her fourth graders to the computer lab after a math lesson. She asked the computer coordinator what was available in math and he told the students what to load. K did not provide any explanations about program handling or the mathematics embedded in the program. She stressed that they have to use the HELP button in order to answer their questions. The students were clicking with the mouse devices and looked on task. A closer look revealed that some were doing mathematics problems but some had problems in program manipulation and were cognitively stuck. Some still kept clicking and changing screens—the educational program *Junior Math Shop* was reduced to a Nintendo game. [Field notes]

Seventh, having a variety of hardware and software and a supportive atmosphere did not always produce a pattern of transfer: N, A, and Y work in a school districts that is rich in hardware and software and the teachers felt an upbeat atmosphere in the school. Still, each teacher is going in a separate direction [Field notes].

Eighth, the essence of the transfer model is the teaching methods employed and consequently students' assignments and products. This model (in a mild form) was found in a classroom but next door and in a neighboring elementary school different patterns were operating pending apparently on the *educational background* and *declared vision* of the teacher in charge of the activity.

In a well to do suburb that includes some of the original farm families we interviewed three teachers (see Table 2):

Table 2
Computer Teachers' Background In One District

Elementary	**Middle**	**High School**
General elementary background	Computer science and English major	Business woman that became a teacher

The middle school teacher with a more substantial background in computers taught most closely to a transfer model while the other two did not.

Discussion

The entire profile of either Repetition or Transfer did not always materialize. These seem to be theoretical constructs that highlight patterns in computer education. In the sample interviewed so far, *teacher's background* seems to be an important variable. Maybe the well-prepared teacher's knowledge base is made up of concepts and rules, while an amateur (like the business woman) has a collection of procedures and "tricks" that are presented to the students.

Apparently a good educational background transferred to new realities, is rich in products and uses, and enables a teacher to envision the end product —a student as a computer user. Such a teacher could also verbalize the vision and create classroom patterns that "push" in this direction. Teacher preparation also appears to be a factor in helping to define student exit competence and in generating cognitively supportive teaching patterns. The second teacher showed student portfolios and said, "these skills will help them find a job." Equipment and software availability, although necessary contributors, were not a final condition for having or not having transfer in the classroom.

This exploration in computer education supports studies dealing with other subject areas; teacher variables are the primary factors in making a difference in quality education. Therefore, studies like this should be considered in the design of teacher education programs. Teaching methods in use should be analyzed so a new practitioner would be aware of the implications of using different teaching methods. Computer concepts are going to be better understood and hopefully transferred in new technological realities. Teaching methods supporting transfer are not unique to computer education (Kinzer, Sherwood & Bransford, 1986; Perkins & Salomon, 1988). Therefore, training teachers to understand and employ these methods should apply to all subject area; "In facing this problem [transfer occurring inconsistently E.J.] instructional programs do well to address the problem of transfer head-on by helping the learners to become explicitly aware of the importance of transfer and to achieve it rather than leave it to fate"(Nickerson, Perkins & Smith, 1985, p. 335).

The three teachers, Y, A and N, were also at different stages as technology users. The literature implies is an important factor in teacher development (Sandholz, Ringstaff & Dwyer, 1990). As A indicated in her interview:

I think probably the thing I think is the most valuable, that I like to do the most, is really have the kids see the computer as something to use as a tool and very useful. A lot of the kids don't have them at home. I was not raised with computers but now, to sit down and write without one, I would be lost. It allows you so much more creativity and different options and you're not locked in.

It appears that a teacher who internalizes computer use as a tool can better model it for his/her students.

This study reveals an improvement in formulating school curricula in the area of computer education, compared to an earlier study (Moskowitz & Birman, 1985). It is teachers' backgrounds and classroom practices that probably produce very different student competence. It is not one set of "thinking skills" that is needed in the computer classroom (see "fragmenting logic," Parker, 1987, p. 54). It is a whole approach of competent teachers viewing information technology as "cognition enhancers" (Dede, 1987) and students as growing individuals able to make intelligent choices in a self-directed manner rather than obediently performing uniform tasks.

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Teaching to Higher Cognitive Levels by Means of a Computerized Conceptual Model

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Introduction

Coming up with higher cognitive level learning activities and test items can be a difficult and time consuming task. A close inspection of such items suggests that certain keywords and sentence constructs are recurring. Combining these with appropriate subject matter content, a "Computerized Conceptual Model" can easily be produced. Computerized models such as these can produce various randomized versions of questions, diagrams, and symbolic exercises each unique and challenging to the student.The utility of such "models" lies in their ability to be used in different ways by various people. A classroom teacher might build a model to produce classroom test items, another instructor might find it more beneficial to allow the students access to a PC where they may build and test their own models. Beginning teachers may find such models helpful in constructing higher level test items.

Background

Each academic term classroom instructors must decide whether to cover additional course content or to slow up and consider working on student's higher cognitive skills such as conceptualizing, reasoning, and problem solving. While the acquisition of more factual information is important (Kramer, 1991), the emphasis on this process usually results in what Adler (1988) refers to as learning by "indoctrination" and goes on to suggest the "facts remembered should not be confused with facts understood."

Indeed, a basic problem confronting teachers at all grade levels is the determination of the proper mix between active and passive learning on the part of the students. True learning occurs only when a response or activity on the part of the student is invoked. While most teachers continue to lecture (Smith, 1990) and students continue to engage in rote memorization, the processes of concept manipulation and reasoning go begging.

Most would agree that the building of higher level cognitive skills is a worthy endeavor, but few engage in it to any great extent. A closer look at this situation suggests that it is difficult to teach in ways that you were not taught and that such activities, once engaged in, tend to be very time consuming. The idea of classification schemes and concept building were widely promoted in the decade of the sixties by federally funded science courses such as CHEM STUDY (Chemical Education Material Study, 1963) and others. A major emphasis in all of these courses was on classification schemes as they apply to the development and utilization of the scientific method. It might be suggested that these attempts to teach to higher cognitive levels fell upon hard times because of the time consuming process of viewing and presenting concepts from various perspectives and permutations.

With the advent of the desktop computer, or PC, a new ray of hope shines.

Conceptual Models

Conceptual models (figure 1) are typically described (Loree, 1971) as mental constructs in which members(pieces of information) with common attributes are bound together by a class rule that prescribes the inclusion or exclusion of other potential members as they are encountered. Every person carries within his mind such models of the world and everything in it, including himself (Nickerson, Perkins, & Smith, 1985). Within these models a person classifies and reclassifies old information and processes new information coming to him via his senses. It has been suggested that the first line of defense against information overload is a person's cache of functional conceptual models. Conceptual models can usually be classified into two categories or types, "Concrete" and "Defined"(Tessmer, Wilson, & Driscoll, 1991).

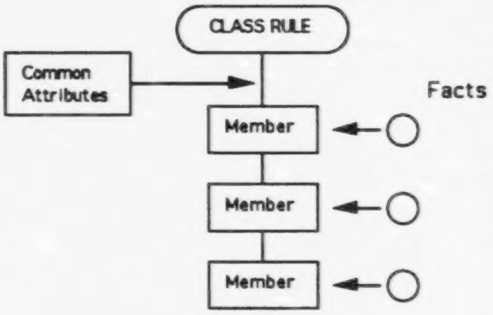

Figure 1.
CONCEPT MODEL

Concrete models typically consist of members whose differences are easily observable, i.e., birds, elephants, roses, galaxies, etc. In contrast to these models are those whose members may be nearly identical in appearance but different in a more abstract sense, i.e., senators versus congressmen, sisters versus aunts, etc. It is in the formation and utilization of these models that the process of "reasoning" enters the picture.

Reasoning

Nickerson et al. (1985) suggests that what we have come to know as inductive reasoning is closely related to the process one uses when he attempts to construct a conceptual model. By scrutinizing new potential members that somehow do not fit the existing models, new rules or classification schemes emerge, the effect being that the model network is expanded or at least altered. This process usually results in the formation of new "information".

In contrast to inductive reasoning, the deductive process involves logical inference, that is, one does not go beyond the information at hand. A great deal of what one "knows" is arrived at via this process. If one were to mention that he grew up in a small town, others might infer that this town had homes, schools, churches, police and fire departments, etc. On the other hand, most would assume that this town had no major art museum, international airport, or NFL football franchise.

Reasoning then is a familiar term representing a not so commonly planned activity. The process of reasoning, in fact the process of thinking, in general, requires a solid background of "learned" facts and a lot more. Just as a pile of bricks does not make a house, a store of facts does not make a concept. Crutchfield (1969) suggests that high level thinking can be improved with training and that one should not assume that these skills will emerge unattended or as a result of maturation.

Reasoning via conceptual models can be thought of as the ability to see and manipulate relationships between units of a conceptual model such as member to member, member to class rule, member to attribute, and member to fact, with a member being the basic building block of a concept. Within this context, each group of members belongs to a domain such as people, objects, ideas, events etc., which can be clearly associated with other members with similar attributes by a clearly stated classification rule. If fact, three distinct skills relating to conceptual models have been identified (Dijkstra, 1991): recognizing single objects, identifying objects that belong to the same group, and discovering relationships between objects of the same group or different groups.

Encoding the Process

It is not the intent of this writer to suggest that even the simplest of conceptual models can be faithfully captured in a computer program (figure 2). What computerized versions of models can do is to provide an "interface" allowing for the

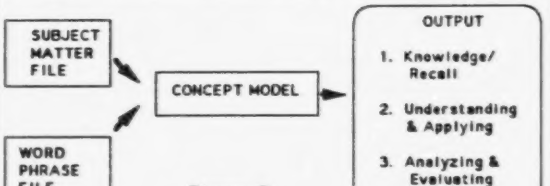

Figure 2.
SOFTWARE DESIGN

generation of questions and exercises. If one were to study a list of well-written learning activities a pattern of recurring words might be noticed. As Chuska (1986) points out, while providing a list of such words, "Once there is something to think about and some background data to think with, then we can consider the ways that knowledge and experience gained can be applied or processed."

An instructional objective in history asking the student to " ... describe the impact of the lack of manufacturing capacity of the Confederacy to the outcome of the war," is not that much different from an objective in astronomy that asks the student " ... to describe the effects of the tilt of the earth's axis on the length of our day." In both examples, key action words are combined with subject matter content in an attempt to invoke specific behavior from the student such as recalling, differentiating, comparing, describing, etc. By using such key words and action phrases as variables it becomes a rather simple matter of electronically scrambling them and coming up with numerous interesting semantic permutations. If the domain of the member is entered, i.e., people, places, objects, the student will be presented a sample list of members as well as a classification rule, both randomly generated. He is instructed to differentiate the members based on the stated rule, or in another instance the student may be presented a list of members as a group and be asked to state a classification rule that fits the data. Finally, the computerized form of the model might present a list of members, facts, and attributes in symbolic form and the student be asked to write a classification rule in symbolic code that would accurately "classify" the information given.

Using the Model

The utility of these computerized models lies in their ease of use and ability to quickly generate numerous unique activities for class use. The following is a list of suggested uses:

1. To generate classroom activities.
2. To allow students the experience of model building.
3. To aid beginning teachers in the creation of higher cognitive test & activity items.

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Technology and Teacher Education: Paradigm Shift in Instruction?

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Abstract

The outcry for reform in education focuses on the need to better prepare all students for a future in the information- technology age. High drop out rates and growing problems in schools prompt many to suggest modernizing instruction through the use of technology. Currently, the integration of new technologies into education is challenging traditional didactic pedagogy. Guided inquiry approaches to teaching are emerging as the instructional paradigm of the future. This paradigm shift has important implications for teacher education. Traditional computer literacy courses are being replaced by programs centered on the instructional use of technologies within subject matters and disciplines. New technologies are changing the way educators think about teaching and learning. Numerous technology centered programs and schools have been created with many more initiatives underway. The level of technology competency expected of all teachers and the need for technology specialists within schools are two critical issue facing teacher education. The challenge is to develop a realistic plan for change in teacher education programs so that all teachers are prepared to use technology as a vital instructional tool within the context of a new guided inquiry paradigm of education.

Introduction: Need for Change

The current and projected high failure and drop-out rates of children and adolescents, especially disadvantaged and minority students, in our schools suggest the need for some immediate action (Ornstein & Levine, 1989; Solomon, 1990). This need is particularly acute in the inner-cities where most of the socio-economically disadvantaged and minority students are concentrated. Many analysts of education (e.g., Office of Technology Assessment, 1988; National School Boards Association, 1989; Dezell, 1989) propose that schools modernize instruction and training through the use of computer and information technologies much as businesses across our country have done over the last 10 years. The consequences of this proposal are seen by educational experts (e.g., Dede, 1989; Madian 1989) to range from integration of technologies into current curriculum to wholesale restructuring of the curriculum with instructional technology at the center of the change. Moreover, projected shortages of teachers in the next ten years (NSBA, 1989; Bruder, 1989) also suggest that technology may need to take up some of the slack brought about by the impending teacher shortage, especially in urban inner-cities.

If teachers are to begin to use computer/information technology in their teaching, then they must have access to the technology as well as be trained through hands-on activities to use it. Few businesses today would train their employees to use technology in brief workshops on outdated equipment, then place their employees in an office where 50 employees share one or two pieces of equipment. Additionally, few businesses would waste time training employees on equipment of one type when some other particular brand of the machine is currently in use in the business. However, the situation just described is one often faced by teachers attempting to become computer literate, much less a skilled user of instructional technology and software.

The need to apply technology to instruction (Dede, 1989; Bruder, 1989; NSBA, 1989; OTA, 1988) and the proposed restructuring of the curriculum of the public schools (Madilen, 1989; Ornstein & Levine, 1989) demands that teachers at all levels must, at the least, develop basic computer literacy and, more importantly, the knowledge of how to integrate computer technology into the science, mathematics, social studies and language arts curriculum. The recent reform proposed in curriculum emphasizes wholeness, connectedness and process. The use of technology is critical to the new process-oriented curriculum that focuses on critical thinking, problem solving and communication skills. Before these curriculum changes can be fully implemented, classroom teachers must be trained to effectively use technology as a management and instructional tool.

Currently, only a small percent of teachers (Clifford & Guthrie, 1988), especially in inner city school districts, have been trained through extended hands-on experience to begin to integrate technology into instructional activities. The projected shortage of future teachers in critical subject areas such as mathematics and science is another problem that may be addressed by using computers to deliver and assist in instructional activities. It has been suggested (NSBA, 1989; Bruder, 1989) that if current and future mathematics and science teachers can be adequately trained to effectively use technology, this may help overcome some aspects of the teacher shortage problem.

Schools today also need to more effectively use technology in the education of at-risk and disadvantaged children (Solomon, 1990; Butzin, 1990). Many of these children are in the poor, large inner city schools where the costs of technology have generally prohibited its integration into instructional activities. Only a few of the inner city school districts have been able to keep up with advancing technology, much less integrate its use into instructional activities. Many of the teachers within these districts still have little, if any, exposure to computer technology on a sustained base. Many have only read about or been initially exposed to computer literacy in in-service, only to return to their home school with no access to computers.

The growing clamor for change in education and teaching from parents, communities, businesses and political leaders, minority leaders and educators alike as well as the belief that technology can assist in the improvement of teaching and learning in schools demands that teacher educators and school districts ask and answer several questions. The more important questions to be addresses are:

1. How best to educate current and future teachers about the effective use of technology as an instructional tool?
2. How best to facilitate and support teachers in their use of technology for instructional purposes?
3. How to effectively plan for the infusion of technology in the classroom in times of limited resources?

Instructional Issue: Literacy or Vital Tool

Traditionally, as new technology has become available universities and school districts have approached the educational needs of teachers pertaining to technology through a "literacy approach." This approach primarily involves offering specific courses and/or workshops to bring teacher up-to-date. This course/workshop strategy to training goes back to the introduction of the overhead projector, film strips and motion pictures. This same strategy has more recently been employed for training in video and computers. The courses offered have focused on "knowing about" and "how to operate" the technology instead of on the appropriate instructional use of the technology. Even more problematic is that many of these courses have had only limited hands-on time and, therefore, limited transfer potential. Too often teachers leave these classes with limited access to the technology and, thus, have little opportunity to even use the technology. This "literacy" approach to technology education for teachers continues in many, if not most, educational environments today. The training continues to emphasize technology over pedagogy and declarative over procedural knowledge.

Teachers and teacher educators alike are beginning to question the "literacy approach" to instructional technology training for teachers. The awareness that the new technologies, especially the computer, have the potential for transforming instruction, not just enhancing traditional instruction, is growing among educators. Amaral (1983), Martin (1987) as well as Wiske and Houde (1988) suggest that classroom instruction should move toward a "guided inquiry" approach assisted by technology. Adopting an inquiry approach to instruction will require a fundamental shift in our educational paradigm. Advancing this instructional model using technology as a aid will require extended assistance and re-education of teachers in order to make this change. Moreover, significant modifications in pre- service teacher training programs will be required to prepare teachers for new roles and transformed classroom learning environments. The assistance and modifications needed to affect this change will require a combination of experienced advisors and opportunities for collegial exchange among fellow teacher innovators.

Paradigm Shift: Lecture to Inquiry

The "guided inquiry model" of instruction assisted by technology has several characteristics that set it apart from the traditional teacher directed, didactic approach. The teacher's role moves to a facilitator, guide and resource instead of the expert who knows all. Classrooms are transformed into collections of learning centers as opposed to a lecture room full of chairs in rows all facing the front. Students work independently and in small groups rather than in a large group or in isolation. Cooperative interactions among students and teacher are the norm in place of competitive and judgmental exchanges. Self-managed activity is the prevailing means of control as replacement for external rewards and punishments. Integrated learning of subjects is preferred to isolated learning of facts and topics. Higher order thinking and problem solving are valued over rote memorization and basic skills. Portfolio assessment is favored in place of multiple choice tests and standardized exams.

The incorporation of learning centers in the classroom is greatly facilitated by technology. The ability for students to work alone or together and more easily access information without assistance from the teacher is greatly enhanced by the new technology. Learning centers permit more flexible class scheduling and sensitivity to student differences such as variations needed with regard to time on task to experience success. Additionally, learning aided by technology stimulates greater interest in learning and thinking as well as more desire to explore on one's own. Teachers using learning centers find their role enhanced. They become a facilitator and resource while increasing positive interactions with students. These changes are empowering for both students and teachers. Classrooms are transformed into active learning environments that are much more responsive to all modes of learning.

One of the more fully developed learning center programs designed to foster an inquiry approach to instruction is IBM's *TLC* (Teaching and Learning with Computers) Program for Grades 1-6. Using the latest affordable technology, IBM has designed an integrated systems of hardware, courseware and training for use in learning centers. The courseware developed is in language arts, mathematics and science. The computer equipment consists of a 5-15 station networked system designed to be used in the teacher's classroom, not an isolated computer lab. The system is designed to be integrated into the current curriculum of schools, while at the same time fostering a change in the nature of the classroom learning environment.

Wilson (1988) proposes that the primary goal of education is for students to develop understanding and advocates that technology can be used to further understanding. However, according to Wilson technology should be use selectively for dynamically modeling of key concepts and for fostering inquiry. As a result of this view, metacourses or teaching models that can be gradually integrated into existing curriculum and practice are suggested. Research on metacourse materials developed by Wilson's group at Harvard indicates that educators underestimate the logistical challenges of implementing technology in the classroom and the support needed by teachers who are attempting to integrate technology into instruction.

An example of a whole school attempting to change its instructional approach using technology is Cincinnati Country Day School in Ohio (Rudowski & Hofmeister, 1991). At Country Day the classroom environment is being restructured into the classroom as a workspace. In these classrooms students work, talk, construct and discuss their work. The idea is that people who are learning and thinking need to share and discuss their ideas with others. The focus is on helping students create and use their own knowledge. The transformation is being assisted by technology because it fits into the vision of education evolving at the school. The technology is enabling students and teachers to do things that were not possible without technology.

Several recently opened schools have been designed around the inquiry model of instruction assisted by technology. These are the Saturn School of Tomorrow in St. Paul (Hopkins, 1991) and the School of the Future in New York (Solomon, 1990). These schools are attempting to establish classroom learning environments with the help of technology that are more student learning, process oriented as opposed to teacher presentation, content oriented. These schools strive for an instructional program that emphasizes inquiry, self-managed learning, cooperation, small groups and teacher as guide. A key aspect of each these projects is that they are driven by a clear vision of education more than technology. Technology is seen as in the service of the educational vision of helping students learn what they could not or can not learn in traditional school environments.

The "inquiry instructional model" assisted by technology has several characteristics in contrast to the traditional "didactic instructional model.

"Traditional Model"	**"Inquiry Model"**
Teacher Centered	Student Centered
Content Focus	Process Focus
Competitive Activities	Cooperative Activities
Class Work	Student Work
Large Group Oriented	Small Group Oriented
Teacher Expert	Teacher Guide
Teacher Managed Learning	Self-Managed Learning
Rote Memory	Thinking Skills
Passive Learning	Active Learning
Segregated Subject Domains	Integrated Subject Domains
Basic Skills	Higher Order Skills
Topical/Linear Knowledge	Networked/Integrated Knowledge
Desks & Books	Learning Centers & Resources
Standardized Curriculum	Customized Curriculum
Teacher Assisted	Peer Coaching
Tests & Exams Evaluation	Portfolio Assessment

Planning for Change: Vision, Implementation & Maintenance

Several important issues regarding teacher education (e.g., Strudler & Gall, 1988; Wilson, 1988) have been raised as a consequence of proposing that technology be infused into classroom instruction as an aid in changing from a primarily didactic to an inquiry approach to education. A few examples of the issues identified are 1) teachers' and schools resistance to change, 2) the view that this fad will also pass, 3) lack of resources to make the change happen, 4) problems with relevant training and transfer, and 5) questions pertaining to whether the follow-through and support sufficient to sustain innovations will exit. A critical issue overriding all others is the need for schools and universities to work together to plan for change and anticipate the educational needs that will result from change.

Levinson (1991) outlines three phases of the change process - 1) planning, 2) implementation and 3) maintenance. The planning phase involves developing a strategic "vision" and defining the problems to be solved by technology. The vision must be developed at the policy and management level, while implementation must be from the classroom upward. The vision must become a shared vision with teachers having participated in its formation and coalitions developed to support the vision. The implementation must integrate human and technical resources. The challenge of this second phase is to maintain the integrity of the vision while addressing disruptions, diversions and obstacles. The maintenance phase begins when the change becomes the established norm or practice. This phase involves developing the support networks of resources that will sustain the change including funds and personnel. The maintenance phase will function well only if the linkage between the goals, change and technology is still in the forefront.

November (1991) has identified several lessons that educators can learn from industry regarding the planning process. These lessons include 1) the future not the past must guide planning, 2) empowerment of workers to make decisions facilitates change, 3) good planning starts at the top, 4) information is most useful closest to the customer, and 5) everyone needs to be a learner and decision-maker. Knupfer (1987) and Becker (1991) report on surveys conducted with educators regarding technology in schools. The results of these surveys paint a picture of a general lack of vision, vague educational goals, out of date technology and training, and confusion as to the roles of the teacher versus the technology specialists. Becker concludes that the real challenge was to work within the sever constraints to adapt schools to the opportunities presented by technology in ways that are effective and to disseminate the results to other educators, especially teachers.

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The Integration of Teacher Education and Technology: A Constructivist Model

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Abstract

A constructivist approach to the integration of technology and mathematics education views teachers as facilitators of learning who model the learning process using technology. A general model for the integration of technology and teacher education involves four interactive components: (1) the identification of the relationships between teacher education and technology, (2) the creation of a supportive learning environment, (3) the recognition of dispositions to be modeled, and (4) the review, refinement, and elaboration process. The results of an experimental study that compared 89 preservice teachers involved in a constructivist model with those involved in a more traditional, didactic model indicated the effectiveness of the constructivist approach.

The integration of technology and teacher education involves more than just a physical change, a supplemental add-on to instruction, or a curriculum that dictates the integration of technology (Dwyer, 1991). It is a blend of thinking, learning, and instruction using the tools of technology to form an entire system of learning and teaching. This kind of blend necessitates that teachers have full usage, easy accessibility and understanding of the potential of technology (Sheingold, 1991).

To most effectively create this system of learning and teaching, a model for that integration would seem to be necessary. Two specific approaches to teaching were considered for the purposes of this integration model: the didactic approach and the constructivist approach.

The didactic approach, one of information transmission, views teachers as masters of particular knowledge domains, whose job is to transmit expertise to students primarily by lectures and recitation. In the didactic class, students memorize facts and concepts of the domain, practice skills until they have mastered them, and demonstrate mastery on appropriate tests. Using the didactic perspective as a framework for a model of technology and teacher education integration, teacher educators would spend most of their time explaining kinds of software, demonstrating the use of technology in education, and training teachers to work with different types of hardware. It would be important for students working under the didactic model to pass tests covering technology and its role in education and to demonstrate their ability to use various hardware and software packages (Brown, Collins, & Duguid, 1989).

The constructivist model, one of facilitating learning, views teachers as facilitators whose main function is to help students become active participants in their learning and make meaningful connections between prior knowledge, new knowledge and the processes involved in learning. The role of students from this perspective is to construct their own understandings and capabilities in carrying out challenging tasks. The most important component of instruction in the constructivist model is the modeling of the learning process. When the integration of technology and teacher education is viewed from a constructivist framework, instructors of teachers would need to model teaching and learning with technology. The instructors would design experiences that require teachers to make connections between prior knowledge, new knowledge and the processes of technology use. Furthermore, and most importantly, teachers involved in teacher education classes would be required to construct their knowledge of the subject content and technology in the role of students constructing their own understandings (Brown, Collins, & Duguid, 1989).

To most effectively integrate technology into a teacher education program, a constructivist model is proposed. The model that will be described in this paper will be based on the constructivist framework and specifically detailed in the area of mathematics education. For the purposes of this paper, the philosophical and theoretical view of constructivism will be described in further detail, a general overview and then a more specific constructivist model will be outlined, and a preliminary study will be related that describes both the didactic and constructivist approach in mathematics methods' classes.

Philosophical and Theoretical View of Constructivism

To a constructivist, all knowledge is constructed, at least in part, through a process of reflective abstraction. During the constructive process, cognitive structures are continually developing and transforming as new information is processed. Pedagogical constructivism suggests methods of teaching that would induce the changing or transformation of knowledge using purposeful activities and modeling (Noddings, 1990). In fact, from a constructivist viewpoint, learning is viewed as being contingent upon the activity and involvement of the learners. Piaget in his early theory of knowledge, stressed the notion of the subject's active construction in learning. The stages of development each involved a search for meaning by the learner as new information was assimilated into existing cognitive structures (Maher & Alston, 1990).

Learning from experience would be an essential element in education from a constructivist viewpoint. Constructivists emphasize the importance of appropriate forms of experience. To effectively assimilate new information into existing cognitive structures, students need to be involved in situations based in reality that would facilitate the construction of knowledge. Group collaborations, genuine problem-solving situations where the answer is varied and the process is flexible, illustrations of the reality of the classroom using video-tapes, and writings and discussions that require reflection would all be viewed as appropriate experiences in the constructivist classroom for teacher education (Davis, Maher, and Noddings, 1990).

General Overview of a Constructivist Model

Figure 1 illustrates a constructivist model for the integration of technology and teacher education. The interactions between the different components of the model and the elements of review, elaboration, and refinement indicate the continual process of construction inherent to this type of model. First, the specific relationship between the content area of teacher education and technology needs to be outlined. Note that the elements of this relationship would be continually reviewed, elaborated and refined as new knowledge is processed. Consistent with the importance of the active involvement of learners, specific activities that establish and model that relationship need to be planned. Secondly, plans need to be established for the creation of a supportive classroom environment. The created environment could involve classroom videotapes, interviews with students, and "slices of reality" which necessitate the process of reflection. Finally, dispositions of both students and teachers and the process of knowledge construction need to be recognized and modeled by the instructor of the class. Students in the teacher education class need to see the learning and teaching that takes place as a student and a teacher; both experiences are essential for effective modeling.

To apply the general model to mathematics education, the relationship between teacher education and technology as it applied to mathematics education for elementary teachers was identified. Plans were then specified with particular mathematical activities and experiences that would allow learners to process those relationships. Managerial strategies for creating an atmosphere of discovery, reflection, and realistic simulations were investigated, tried, and refined. Provisions for the modeling of the dispositions necessary for the learning and teaching of mathematics were identified so that the awareness of those dispositions could be effectively modeled. Finally, based on the four elements described in the model, a mathematics methods class for elementary teachers was planned and implemented.

Relationships between Mathematics Education and Technology

Three distinct relationships were most obvious: (1) the problem-solving focus of both mathematics and technology, (2) technology as a tool for the learning of mathematics, and (3) technology as a tool for learning how to teach mathematics.

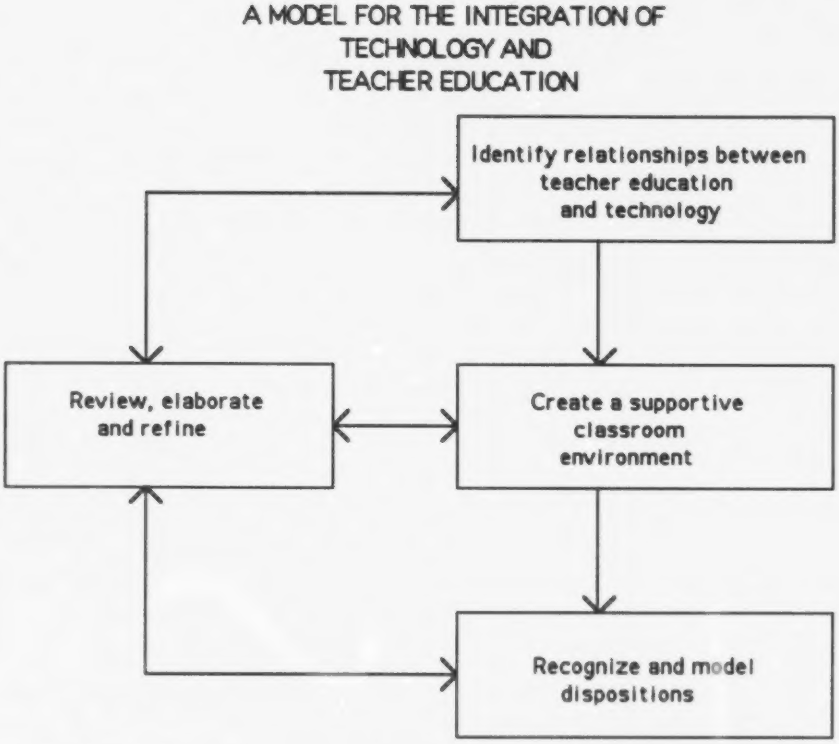
A MODEL FOR THE INTEGRATION OF TECHNOLOGY AND TEACHER EDUCATION
Identify relationships between teacher education and technology
Review, elaborate and refine
Create a supportive classroom environment
Recognize and model dispositions

Figure 1: Specific Constructivist Model in Mathematics Education

Problem-solving focus

The learning and teaching of problem-solving strategies are essential components to any mathematics program. To learn strategies as students of mathematics, participants in the class used problem-solving software specifically designed to demonstrate particular strategies. In Wings' *Incredible Lab,* students were required to make organized lists and tables to solve the problem of what chemical made what type of monster. In Sunburst's *Pond* , users had to identify a series of increasingly difficult patterns to help the frog move through a lily pond. Calculator technology was used to generate data to solve a large variety of routine and non-routine problems using guess and check strategies, pattern identification strategies, and the use of tables or organized lists.

To learn how to teach problem-solving, both inductive and deductive methods were introduced using different kinds of technology. Some students learned how to draw figures using IBM's *Geometry: Geodraw* from an inductive approach with experimentation, discovery, and conjectures. Others learned the methods deductively with teacher instruction, rule-stating, and practice sessions. Wing's *How the West Was Won Two Three,* a program that allows students to practice order of operation and equation skills, was also taught both inductively and deductively. Calculators, specifically the TI Explorers, were used to introduce inductively and deductively fraction concepts and number theory . Participants in the methods' class wrote lessons from both perspectives and compared the two approaches for effectiveness and motivational value.

Technology as a tool for learning mathematics

Many elementary majors view mathematics as a topic they had or have difficulty learning. Because of insufficient mathematics backgrounds, most students in an elementary mathematics methods class learn mathematics along with learning how to teach it. Technology is an excellent tool to help students with a wide range of abilities learn mathematics.

The collection and graphing of data and the pictorial representation of particular concepts are important to the understanding of mathematical abstractions. The Toolmaker in IBM's *Money, Time, and Measurement* was used to record class and group results of the Metric Olympic Competition. Students used IBM's *Problem Solving Lab* to graph and analyze the results of a roller coaster experiment. IBM's *Math Concepts IV* and

Sunburst's *Balancing Bears* were used as pictorial examples of multiplication of fractions and subtraction of whole numbers respectively to help students connect the use of concretes (manipulatives) to abstractions (symbolism).

Technology as a tool for learning how to teach

The primary focus in teacher education is obviously teaching teachers how to teach. Technology provides an excellent tool for demonstrating and practicing the methods and skills of teaching. Students wrote extension activities from lessons presented in a variety of software packages, they designed and wrote concept lessons using interactive programs, calculator technology, or software packages, and student partnerships surveyed and matched appropriate software to specific objectives for learning. Wing's *Puzzle Tanks* was used to generate lists of lower and higher level questions and then those questions were practiced on peers. In addition, the skills necessary in the assessment of performance, product, and process were practiced using IBM's bookmark system, Sunburst's recording data, and student calculator projects.

Creation of a Supportive Classroom Environment

To implement the activities identified in the relationships between technology and teacher education, decisions had to be made regarding management strategies of the mathematics education classroom.

Learning environments in which students could acquire basic concepts, algorithmic skills, heuristic processes, and habits of cooperation and reflection were recommended by constructivists in mathematics (Cobb, Wood, & Yackel, 1990). Simulated environments (for example, cooperative groups solving problems generated by Sunburst's Factory), reflective environments (for example, the writing of journals using word processing packages), and video environments (for example, videos of actual classroom settings of children using technology placed within a Linkway package or videos of students solving problems) were all used to create an environment that would support the prospective teacher in his or her learning.

Specifically, a four hour session would involve whole group activities, small interactive groups, and/or individual activities sessions in which technology was incorporated within a variety of managerial strategies. A plan for a four hour session dealing with fractions, decimals, and probability is provided to illustrate the various types of classroom environments that were created.

Study: Examining the Use of the Constructivist Model

A preliminary, informal study was conducted to describe the effect, if any, the constructivist model of technology integration in an elementary methods class had on the future use of technology of preservice teachers. For this present study, students were involved only in a one-hour mathematics methods course for elementary certification. This time requirement resulted only in 24 hours of class time over a six week period.

Method

Four undergraduate elementary mathematics methods classes (n=89) were involved in the present study. Two of the classes met at night and two met for morning sessions. One morning class and one evening class each were randomly assigned to the control group with the remaining groups assigned to the experimental group. The same instructor taught all four classes. The classes students attended were decided by students during their registration.

The two classes in the control group (n=41) received regular instruction in the mathematics methods classroom, with one class period (4 hours) spent in the computer lab, demonstrating and practicing the use of both calculator and computer technology. The regular, non-technological instruction in the mathematics methods classroom was taught using a constructivist approach. Technology was introduced as a separate entity (teaching and learning mathematics + technology use) and the integration of technology into the mathematics program was discussed using a didactic approach, not modeled.

The two experimental classes (n=48) received mathematics instruction with the use of technology based on a constructivist approach. While the total amount of time spent using computers and calculators was the same (4 hours), students in the experimental classes used technology every class period. Technology use was modeled (teaching and learning mathematics using technology, manipulatives, etc. as tools) by the instructor, by pre-service teachers acting in the role of a teacher, and by pre-service teachers taking the role of students.

Results and Discussion

Data were collected from three different sources: (1) individual interview with the instructor ("Describe what I would see if I observed you in your first teaching experience."), (2) five student-developed lesson plans with at least one requiring technology use, and (3) daily journal writings on a variety of mathematics topics.

Fractions, Decimals, and Probability

A Lesson Plan for Elementary Mathematics Methods (4 hour session)

Focus: Average Day graph - Estimate the number of American adults on a diet (101,280,321). Change estimate after additional information is given (more than 60,000,000 are women).

Whole group Instruction: Decimal notation using 100 squares - tenths, hundredths, and continuum for understanding of decimal concepts. Introduction to understanding and operations of fractions using manipulatives.

Center A: Pattern blocks - If 2 yellow hexagons equal 1, what do the other colors represent? (generate a list of possible fraction lessons you could use with students and pattern blocks)

Center B: Order Up game with Fraction Factory pieces (comparison game - teacher-directed)

Center C: Connecting manipulative and visualization (Math Concept IV, Unit 6,Using the Models, Activity 7) and concept of multiplication of fractions.
COMPUTERS

Whole group activity: Estimate the number of pennies in the room (or the number of beans in a large container). Record data using stickies on a bar graph. Discuss mode, median, and range. Count the pennies at one table. Students may change estimations. Recalculate mode, median, and range. Continue gathering data and discuss how the description of the graph changes. Use COMPUTERS to put the data into a more permanent form.

Center A: Play Pig with 2 and 3 dice. Discuss which method would produce the most ways to win. (paired activity) Pig rules: The goal is to reach 100 first. Your score is calculated by adding the sum of the dice each time you roll to your previous sum. If you roll two ones, your score returns to zero and you must start over again. If you roll only one 1, your turn is skipped.

Center B: Spinner design games and probability (teacher-directed)

Center C: Statistical questions - Gather data using CALCULATORS and graph the results on Graph Toolmaker (IBM) for COMPUTERS.

Summary: How much money do I have in my bag? Groups of students ask questions to which teacher can only respond yes or no.

Journal Writing: "It takes too much time to introduce students to fractions using blocks and other manipulatives. We should just teach them the algorithms they need to add, subtract, multiply, and divide fractions. That's what really is important." Respond to this statement made by a fifth grade teacher.

To determine a pre-service teacher's future use of technology, points were simply recorded when the student mentioned the use of some form of technology (1) during their interview with the instructor, (2) in more than one lesson plan, and/or (3) in their daily journal writings. Subjects who received four or more points in any combination of the three data sources were classified as "projected users of technology in their mathematics classrooms." Subjects who receive less than four points in any combination of the three data sources were classified as "projected non-users of technology in their mathematics classrooms."

Descriptive statistics indicated that almost 85% of the pre-service teachers in the experimental group will use some form of technology in their mathematics classrooms. Contrasted with only 46% of the pre-service teachers in the control group who will use technology in their mathematics classrooms, these results suggest that the constructivist model for integrating mathematics education and technology has some potential in teacher education. The quantity of the use of technology in mathematics instruction was fairly consistent within the experimental group, with 83% of the pre-service experimental teachers stating that computers and or calculators were essential instructional tools in their classrooms.

This was a preliminary study of the constructivist model of the integration of technology and teacher education . More specific, experimental research needs to be completed. Pre and post measures of attitudes toward instruction and technology, analyses of lesson plans for uses beyond practice and reinforcement, and longitudinal studies of actual usage of technology during first and second year teaching need to be done before any conclusions can be drawn regarding the effectiveness of this model. At this point, lesson plans seem to indicate that pre-service teachers see computers primarily as CAI tools, suitable for reinforcing concepts and practicing skills. Expanded uses of technology as instructional tools that help teachers introduce new processes or content to students or as diagnostic tools that help teachers observe the thought processes of students need to be further developed within the specific model.

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SIMULATIONS

Introduction

The papers in this section clearly illustrate the rapid expansion of computer-based simulations in the field of education. Rebecca Brent, Dee Anna Willis, and Betty Beacham are developing *PLUS*—an interactive tutorial designed to help preservice teachers at East Carolina University to acquire complex lesson planning skills. Their simulation will be used in language arts instruction. At the University of Virginia, Harold Strang and his colleagues are continuing to assess the skill-training efficacy of his self-administered teaching simulation. Their paper addresses whether having preservice teachers complete the simulation cooperatively yields higher skill-training outcomes than having them complete it individually. At Auburn University and Valdosta State College, Terrance Rucinski and Daisy Arredondo-Rucinski are using computer-assisted instruction (CAI) and videodisc technologies to create simulations designed to enhance teacher decision-making skills in instructional contexts. Their research is anchored to the Dimensions of Learning (DOL) integrated model of instruction. Working with university and public school faculty and with Apple Computer Corporation, Donn Ritchie and Bernard Dodge are using computer and videodisc technologies to increase the cultural awareness of students in an inner-city public school in San Diego. Their innovative approach allows students to use a Macintosh microworld template to create simulations that address a number of important learning goals.

The evolving diversification in computer-based simulations generates questions as to the relative benefits of the differing models. In the final paper in this section, Louis Berry, at the University of Pittsburgh, initiates research in this important area by comparing preservice and inservice teachers' performance on a text-based simulation versus a videodisc simulation. Additional comparative research will further define the relative strengths of the emerging simulation technologies.

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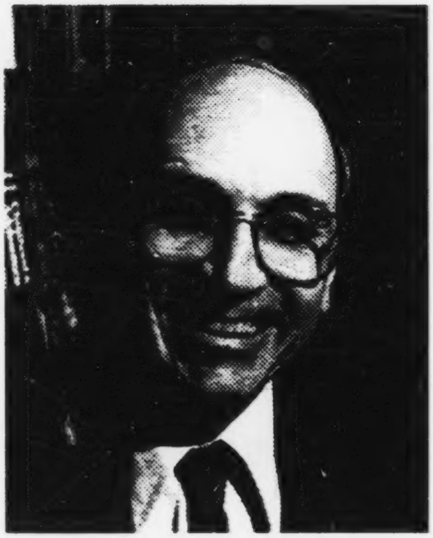

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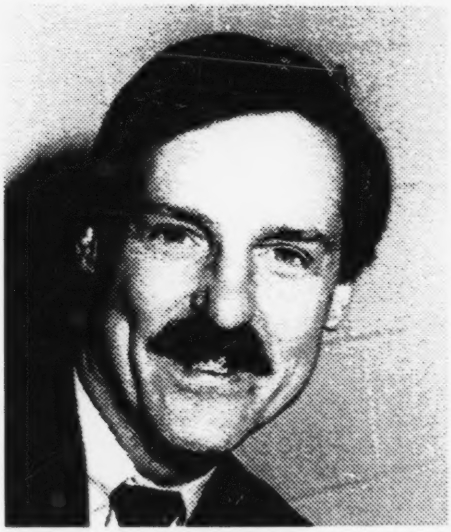

David Costlow

PLUS—Planning Lessons Using Simulation: A Development Project

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Abstract

Faculty from East Carolina University and the University of Houston are developing a set of instructional modules called *Planning Lessons Using Simulation* (PLUS). PLUS will include an interactive lesson planning tutorial; an interactive simulation of the lesson planning process; and a guided planning protocol. The initial application of the program is to the use of the Six-Step Lesson Plan in language arts instruction. Subsequent modules will extend the approach to other lesson types and subject areas. This paper outlines the steps in the project"including identification of the need, review of the current status of the field, and formulation of an overall framework"and describes the current status of development.

Introduction

Computer simulations have the potential for dramatically changing the way learning takes place in the university classroom; unfortunately, there are few simulations specifically designed for use in teacher education. Faculty from East Carolina University and the University of Houston are developing a set of instructional modules called *Planning Lessons Using Simulation* (PLUS). This paper outlines the initial steps in the project"including identification of the need, review of the current status of the field, and formulation of an overall framework"and describes the current status of development.

Identification of Need

Several of us on the faculty at East Carolina University have noticed in recent years that many of our teacher education students have difficulty planning lessons effectively, even after receiving extensive instruction. For example, students are often confused about the components required in the Six-Step Lesson Plan, a direct instruction model adapted from teaching effectiveness research (Hunter, 1984). Use of the lesson plan, which consists of a prescribed series of steps (i.e., Focus/Review, Statement of Objective, Teacher Input, Guided Practice, Independent Practice, and Closure) is required in NorthCarolina. Despite detailed coverage of the model in courses on both language arts and on planning, instruction, and evaluation, students commonly misuse or ignore some of the steps (e.g., by beginning lessons without an attention-getting activity or review of previous material or by not making provision to check for understanding during or after the presentation of new material).

The students become more confused when they are exposed to other lesson types such as concept attainment, inquiry, role-playing, simulation, and cooperative lessons. Many of them are unable to determine what type of lesson is most appropriate for a given objective, and they often fail to take into account the various factors that impact planning decisions such as student needs, curriculum guidelines, available materials, and time limitations. Contemplating this situation, we began to explore ways to help students prepare more effectively to deal with the planning decisions they will be required to make in their classrooms.

Review of Lesson Planning Research

Decisions made during lesson planning help shape the classroom environment and establish routines that reduce the number of decisions that must be made once teachers are actively engaged with students (Yinger, 1979). Numerous lesson models imply that planning is a linear process beginning with the specification of objectives and proceeding to the sequencing of activities andspecification of evaluation procedures. Actual experience and the limited amount of research on planning suggest that the process is not linear but rather involves a complex series of decisions about content sequence, grouping, classroom activities, evaluation procedures, and use of instructional time based on a wealth of knowledge the experienced teacher has internalized (Berliner, 1986; Peterson, Marx, & Clark, 1978; Sunal & Haas, 1989).

The problem then becomes how to teach preservice teachers, who do not have an extensive internalized knowledge base, to plan for instruction in ways that enable them come to grips with the many factors at work in the process. After considerable reflection, we settled on simulation as potentially the most effective technique.

Review of Simulation Research

A simulation is an attempt to "mirror reality in a simplified manner" (Rockler, 1988, p. 94). Simulations have the potential to motivate learners, to involve them actively in learning, to make theory relevant, to facilitate transfer of skills, to add variety to the learning environment, and to encourage positive student attitudes (Flaitz, 1986). Computer-based simulations offer the additional advantage of being highly interactive.

Many descriptive articles about simulation have been written and a number of authors have endorsed the effectiveness of simulation as a teaching tool (Copeland, 1989; Rogers & Reiff, 1989), but literature reviews (e.g., Flaitz, 1986) reveal few research studies into the effectiveness of the technique in teacher education. One of the reasons for the scarcity of research may be the relatively small number of working simulations that have been developed for teacher education (Willis & Willis, 1991).

A small number of notable simulations exist, however. One is the Curry/Strang Teaching Simulation (1991) developed by Harold Strang at the University of Virginia's Curry School of Education. Users teach a review lesson of spelling or math, handle instructional decisions and questioning skills, and deal with the types of misbehaviors most common in a typical classroom. Repeated studies have shown a strong training effect in basic teaching skills such as the use of think time and prompting (Strang, Landrum, & Ulmer, 1990; Strang, Vekiari, & Tankersley, 1991). In another project, Dee Anna Willis developed the Informal Reading Inventory Simulation (IRIS). Students using IRIS scored significantly higher on a test of Informal Reading Inventory administration and scoring skills than did students in a control group (Willis & Willis, 1991).

Research results thus indicate that computer-based simulation can be an appropriate medium for helping preservice teachers grapple with the complexities of lesson planning in a controlled waybefore they have to deal with these complexities in actual classrooms.

Formulation of the Overall Framework for PLUS

Development of a software package to meet a specific need is a complex task. As we currently envision it, the program will be developed in a series of phases: the first three phases will concern application of the Six-Step Lesson Plan in language arts, and subsequent phases will expand the program to cover other lesson types and a wider variety of subject areas. The phases are as follows:

1. **Tutorial Development.** An interactive tutorial is intended to help students acquire a basic knowledge of the components of the Six-Step Lesson Plan. The tutorial contains an overview of the model, material and examples for each step, and self-checking quizzes.
2. **Simulation of the Planning Process.** Information will be gathered on how experienced teachers go about planning direct instruction, and the results will be codified and used to develop a simulation of the process. Preservice planners using the simulation will receive classroom scenarios, make lesson planning decisions, see the results of those decisions, and receive corrective feedback.
3. **Development of a Guided Planning Protocol.** Once students have gained experience with the complexities of the planningprocess, they will be ready to begin independent planning of a variety of lessons for field experiences and student teaching. A protocol will be developed to lead them through the planning process for their lessons using questions and prompts to guide their thinking and reminders to access appropriate information. This approach is called cognitive monitoring and is consistent with work done by Neely (1986) in training students in self-interrogation as a way to increase their awareness and regulation of their own thinking while planning. Neely used such questions as "What role will I take on during this lesson?" "What students have special needs that

should be attended to in this section of the lesson?" "How will I gain student attention?" "How will I check on student understanding?" Similar questions coupled with prompts about the components belonging in each step of the lesson should help students plan more effectively for direct instruction lessons. The students will type in their plans in response to the computer prompts; the program will then print out finished plans suitable for immediate use.

4. **Expansion to Other Lesson Types and Subject Areas**. Similar three-phase development programs will be applied to lesson models other than direct instruction and subject areas other than language arts.

The next sections will outline in greater detail our conceptions of the first three phases and the current status of the development.

Lesson Planning Tutorial

Because our students are required to use the Six-Step Lesson Plan for much of their lesson planning in the classroom, this model has been selected as the first one to be simulated. The tutorial is programmed using Authorware (1988), a flexible authoring system that operates on Macintosh and IBM-compatible computers. It

- Allows users to select from a menu an overview of the model rationale, material about each step in the lesson model, and a final self-check.
- Presents information about each of the steps in the Six-Step model: Focus/Review, Statement of Objective, Teacher Input, Guided Practice, Independent Practice and Closure. The material presented includes both descriptions of the steps and examples from lesson plans.
- Concludes each step with a self-checking quiz.
- Provides a final self-check that can be used as (a) a pretest to direct users to the steps needed or (b) a posttest to determine mastery of the material.

An initial version of the tutorial is now being field-tested by preservice students and teacher educators. Research on its effectiveness will begin during the 1992 fall semester when students who enroll in a generic teaching methods course and in a language arts course will be randomly assigned to a control groupor a group that uses the tutorial. Students in both groups will be tested on material included in the tutorial and will be assigned to develop independent lesson plans. Between-group comparisons of the results will provide an indication of the effectiveness of the tutorial.

Lesson Planning Simulation

The second phase of the project will involve actually simulating the planning process. We will begin by gathering information from experienced and preservice teachers, following a process developed by Peterson, Marx, and Clark (1978). Both experienced and preservice teachers will be instructed to think aloud during the planning of a week of direct instruction lessons, stating the information they use and the decisions they consider. These tapes will be transcribed and analyzed to determine common elements in the planning process. Each teacher's statements will be sequentially coded as related to such categories as objectives, higher-order and lower-order subject matter, instructional process, and materials. The coding should reveal the information teachers access in planning and when they access it. The results will be used to construct separate models of the planning processes used by experienced teachers and by preservice teachers.

The simulation will then be structured to move preservice teachers in small steps toward the process followed by experienced teachers. Simulation users will access information about student learning needs, behavior, and previous experiences, content to be covered, curriculum guidelines, and available materials and resources during specific points in the lesson development in much the same way experienced teachers do. Users will then make decisions about their lessons and see the results of those decisions.

Plans have been developed for the gathering of the data needed to build the simulation. During the months of January and February 1992, twenty-five elementary clinical instructors participating in the East Carolina University Model Clinical Teaching Program will make audio recordings during their planning activities. These teachers have been identified as master teachers by their principals and an objective selection process at East Carolina University. It is expected that they will model the planning process used by highly skilled experienced teachers. During March 1992, two groups of preservice student teachers, one in the Model Clinical Teaching Program--a year-long internship program for senior education students--and another in the traditional program will also make audio planning tapes to provide information about the planning of preservice teachers. Later in the spring, the information will be transcribed, coded, and analyzed.

Guided Planning Protocol

A checklist of questions and prompts for the Six-Step Lesson Plan has been formulated and class-tested, and will provide a partial basis for the planning protocol. The protocol will also incorporate elements that emerge from the simulation, so that its detailed development will commence when Phase 2 is nearly complete.

Summary

Faculty from East Carolina University and the University of Houston are developing a set of instructional modules called *Planning Lessons Using Simulation* (PLUS). PLUS will include an interactive lesson planning tutorial, an interactive simulation of the lesson planning process, and a guided planning protocol. The initial application of the program is to the use of the Six-Step Lesson Plan in language arts instruction. Subsequent modules will extend the approach to other lesson types and subject areas.

Credits

This development project is partially funded by a grant from theEast Carolina University Teaching Grants Committee and an IBM Teacher Education Grant.

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Cooperative Participation in a Computer-based Teaching Simulation

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Abstract

This two-year project addresses the efficacy of allowing preservice teachers to collaborate during a computer-based simulated teaching experience. Quantitative and qualitative data were analyzed to determine whether the cooperative teaching experience offered benefits in skill training and/or implementation efficiency over a standard individual teaching experience. The findings suggest that practice with the simulation facilitated future performance. Simply allowing subject pairs to complete the simulation simultaneously did not necessarily yield skill-training benefits. Factors including the simulation's physical configuration, participant rapport, and individual communication styles appeared to mediate how the assignment condition impacted skill learning.

Introduction

During the past 10 years, hundreds of preservice teachers at the University of Virginia and at partner sites across the country have completed Curry Teaching Simulations. Throughout their development, the simulations have been shown to be effective tools for training a variety of basic instructional and behavior-management skills (see Strang, Badt, Loper, & Richards, 1985; Murphy, Kauffman, & Strang, 1987; Strang, Landrum & Lynch, 1989). Since 1988, a major research and development strand has focused on increasing the simulations' skill-training efficiency. Initial efforts in this area produced a self-administered simulation--a vehicle that has retained the skill-training effectiveness of its predecessors but requires significantly less hardware and human operator support (Strang, Landrum, & Ulmer, 1991). The current two-year study focuses on increasing the self-administered simulation's skill-training benefits through administration procedures. Specifically, we have assessed whether having participants complete the simulation cooperatively is a more powerful skill-training procedure than having participants complete it individually.

Two-year Cooperative Project

Participants and Procedure

During the fall of 1990, 56 preservice teachers enrolled in an introductory learning and development course in the Curry School's five-year Teacher Preparation Program were randomly assigned either to an experimental or to a control group. All subjects, using the self-administered simulation, taught two back-to-back spelling lessons. Group conditions differed, however, in that subjects in the experimental group completed the first lesson cooperatively—that is, each pair of subjects in this group co-taught the first lesson at the same computer station. Each subject in the control group taught the first lesson independently at a computer station. All subjects in both groups taught the second lesson independently. During the fall of 1991, the study was replicated with a second group of 56 preservice teachers.

Teaching Experience

The teaching experience paralleled that described by Strang, Landrum, and Ulmer (1991). Over the course of the two-hour laboratory experience, subjects first, either collaboratively or individually (determined by group assignment), became familiar with the simulation's features by practicing as many as 15 interactions (events) with a class of simulated pupils. Immediately following this warm-up session subjects, in accordance with their collaborative or individual group assignment, taught a spelling lesson defined by a total of 60 events. During this lesson the class' 12 simulated pupils were preprogrammed (1) to demonstrate varying degrees of enthusiasm, (2) to show relatively low lesson preparation (8 pupils were totally unprepared), and (3) to exhibit a large number of misbehaviors (including 6 occurrences each of daydreaming, unauthorized leaving of seat, and talking out). Subjects received intra-lesson feedback--that is, effective teacher actions yielded desirable pupil outcomes, and ineffective actions yielded undesirable pupil outcomes. Because the current study focused on assessing the training impact of cooperative versus individual group assignment, no post-lesson feedback in the form of screen displays or printed records was provided.

Measures of Teaching Competence

Lesson-generated measures of teacher competence are included in six categories, each represented by two specific teacher actions (dependent variables). In the following list of teacher actions, the (-) symbol immediately following a description denotes that the variable is negatively related to competent teacher behavior.

Category 1. The promotion of positive pupil experiences

Variable 1. The probability that the teacher offers a pupil the opportunity to experience at least one successful spelling experience

Variable 2. The probability that the teacher praises a pupil's effort while interacting with that pupil

Category 2. The use of a variety of successful methods

Variable 3. The proportion of potentially successful class-centered actions that the teacher employs during the lesson

Variable 4. The proportion of potentially successful methods that the teacher uses to intervene misbehavior

Category 3. The introduction of lesson content

Variable 5. The probability that the teacher uses 'think time' to introduce new lesson content

Variable 6. The probability that the teacher uses the ineffective 'can you spell' question to introduce lesson content (-)

Category 4. The maintenance of smooth content flow

Variable 7. The probability that the teacher returns to the current content after intervening a misbehavior

Variable 8. The probability that the teacher abruptly interrupts an event to pursue a different activity (-)

Category 5. The remediation of pupil errors

Variable 9. The probability that the teacher offers a helpful clue while attempting to assist an erring pupil

Variable 10. The probability that the teacher evokes additional errors while attempting to assist an erring pupil (-)

Category 6. The management of misbehavior

Variable 11. The probability that the teacher is effective in an initial attempt to quell a misbehavior

Variable 12. The probability that the teacher effectively prioritizes intervention when misbehavior clustering occurs

Results

Interaction Lapse Times. The first results address how much lesson time subjects devoted to individual interactions with single pupils or with the entire class. Table 1 presents an across-lesson listing of these lapse times.

Table 1

Mean Lapse Times (sec) for Teacher-pupil Interactions by Group Assignment and Year of Participation

	Condition			
	Cooperative		Individual	
Session	**1990**	**1991**	**1990**	**1991**
Practice	57.62	60.89	38.61	35.28
Lesson 1	26.01	27.68	19.56	19.77
Lesson 2	15.05	17.13	15.62	16.41

Competency Performance During Lesson 2. The 12 competency variables reflecting subjects' lesson 2 teaching performance were entered into a multivariate analysis of variance (MANOVA). The MANOVA included two between subject factors: Group assignment (cooperative and individual) and year of completion

Table 2
Means and Standard Deviations for Teacher Actions by Group Assignment and Year of Participation

			Condition			
			Cooperative		Individual	
Var	**Teacher Action**		**1990**	**1991**	**1990**	**1991**
1	Promote pupil success	*M*	.70	.67	.71	.66
		SD	.17	.16	.16	.19
2	Praise pupil effort	*M*	.27	.30	.30	.24
		SD	.15	.15	.16	.11
3	Employ a variety ofclass-centered actions	*M*	.58	.59	.57	.56
		SD	.31	.25	.21	.28
4	Employ a variety of behavior interventions	*M*	.71	.70	.71	.75
		SD	.15	.14	.13	.15
5	Introduce content via 'think time' requests	*M*	.08	.10	.07	.08
		SD	.13	.13	.09	.12
6	Introduce content via 'can you spell' (-)	*M*	.07	.08	.13	.22
		SD	.11	.10	.17	.24
7	Restore preintervention lesson content	*M*	.39	.47	.36	.42
		SD	.32	.26	.27	.26
8	Interrupt an event (-)	*M*	.02	.01	.03	.03
		SD	.03	.02	.04	.03
9	Provide clues to an erring pupil	*M*	.46	.47	.51	.40
		SD	.33	.28	.30	.26
10	Evoke additional errors during remediation (-)	*M*	.24	.22	.14	.17
		SD	.25	.19	.17	.16
11	Quell misbehavior via first intervention	*M*	.83	.85	.86	.79
		SD	.16	.10	.12	.16
12	Effectively prioritize behavior intervention	*M*	.44	.52	.54	.52
		SD	.27	.27	.21	.24

Note. The (-) symbol indicates that the teacher action is negatively related to competence.

(1990 and 1991). The results revealed a main effect for group assignment, $F(12, 97) = 2.25$, $p < .025$. No significant year or group assignment by year effects were found. Table 2 presents the assigned group by year cell means and standard deviations for the 12 lesson 2 competency variables.

Subsequent univariate analyses yielded three significant main effects for group assignment. Specific dependent variables included variable 6, the use of the 'can you spell' request to introduce content, $F(1, 108) = 11.35$, $p < .01$; variable 8, the emission of interruptions, $F(1, 108) = 6.93$, $p < .025$; and variable 10, the evoking of errors during remediation attempts, $F(1, 108) = 4.07$, $p < .025$.

Post-lesson Evaluations of Pupil Preparation. Immediately following each lesson, all subjects in the 1991 replication completed a short questionnaire that required them to identify the 3 pupils that they deemed were least prepared for the lesson (8 were prepared) and the 3 pupils that they deemed were most prepared for the lesson (4 were unprepared). For lesson 2, the cooperative group subjects' accuracy in identifying unprepared pupils averaged 83%. Their accuracy in identifying prepared pupils averaged 73%. Subjects assigned to the individual group achieved accuracy averages of 86% and 71%, respectively.

Discussion

Implications from the Quantitative Results. The quantitative findings fail to present a convincing case for the efficacy of having participants complete the self-administered simulation cooperatively. The substantially longer lapse times per interaction recorded by subjects in the cooperative group during both practice and lesson 1 do strongly suggest that both members of cooperative pairs shared in the teaching effort. This collaborative contribution does not, however, appear to be the major factor responsible for skill enhancements. The results presented in Table 2 indicate that by lesson 2, subjects, regardless of their group assignment, were exhibiting relatively high levels in competencies such as promoting pupil spelling success, praising pupil effort, and rapidly quelling misbehaviors. In addition, subjects in both groups were, by the time they had completed lesson 2, quite capable of evaluating the preparation levels of the pupils in their class. A comparison of the lesson 1 - lesson 2 differences between subjects' mean performance scores on these four variables suggests that practice with the simulation, regardless of group assignment, substantially contributed to the lesson 2 proficiency levels.

The three statistically significant lesson 2 univariate main effects offer little to support the practical significance of the cooperative training experience. First, while subjects assigned to the cooperative group were significantly less likely than control subjects to interrupt lesson flow, the overall interruption frequency during lesson 2, even for control subjects, was extremely small. Second, while subjects assigned to the cooperative group were significantly less likely than control subjects to employ the ineffective 'can you spell' request, they were significantly more likely to evoke spelling errors during their attempts to render spelling remediation.

Implications from the Qualitative Results. With regard to the simulation's intra-lesson training benefits, the quantitative findings were generally corroborated by qualitative data obtained from interviews with subjects after they had completed their second lesson. Regardless of group assignment, subjects generally found the immediate realistic responses that pupils emitted following their teaching actions to be very instructive. As one participant observed, "I also learned that I have a tendency to repeat myself--perhaps to the point where a student might ignore me." Another reported "It's good to learn how to deal with students misbehaving on a computer. I found out some things that absolutely did not work and will know not to use them."

Observational data obtained from the graduate students who administered the simulation coupled with subject post-participation interview results suggest that several factors should be considered in assessing the impact of the cooperative group assignment on subject skill training. First, the physical configuration of the simulation necessarily placed different behavioral demands on the members of a cooperative pair. One subject exclusively controlled the keyboard during practice and lesson 1 while the other contributed solely via verbal input. Occasionally, the subject not controlling the keyboard exhibited overt signs of inattentiveness--signs ranging from postures indicating boredom to repetitive restless behavior.

Another factor linked to cooperative assignment relates to how the members of a pair communicated with each other while they were teaching. When a pair consisted of individuals who were friends, teaching decisions often resulted from open give-and-take verbal exchanges. Pairs composed of individuals who had not established rapport were more likely to exhibit one of three less productive dialogue patterns. In one that promoted competition over skill learning, both members of the pair regularly attempted to exert personal control over "what to do next." A second, characterized by both members displaying non-assertive roles, typically yielded unproductive exchanges such as a "What do you think we should do?" question followed by a "Whatever you think is fine" reply. A third pattern involved one partner (usually the operator) assuming an assertive role while the other partner acquiesced.

Conclusions

The findings of this study support two major conclusions. The most obvious is that the simulation's intra-lesson feedback facilitates the acquisition of both teaching and behavior management skills. This facilitating effect replicates those reported by Strang, Landrum, and Ulmer (1991) and Strang, Vekiari, and Tankersley (1991). As for assessing the facilitating potential of the study's major variable, cooperative group assignment, it is apparent that simply allowing preservice teachers to participate simultaneously in the same simulation does not guarantee mutually favorable results. Factors including the simulation's physicalconfiguration, the participants' rapport, and individual communication styles appear to influence collectively how a "cooperative" assignment will impact both learners. Turning to future research, findings such as those reported in the current study are prompting us to explore more fully the relationship between successful simulation experiences and individual learner characteristics.

Acknowledgements

The research discussed in this paper was partially supported from funds furnished by the Commonwealth Center for the Education of Teachers, University of Virginia and James Madison University.
The authors wish to thank Karen Korgan and Konstantina Vekiari for their help with data collection.

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Developing Teacher Skill in Improving Student Thinking Via Interactive Videodisc

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Abstract

This paper describes an integrative framework for incorporating the past fifteen years of research on teaching and learning and the development of a Level 3 interactive videodisc to be used in an inservice format for teaching strategies for improving student thinking in content built on that framework.

Introduction

During the past fifteen years educators have witnessed an explosion of knowledge about teaching and learning. This abundant research base has resulted in an increasing number of instructional models aimed at improving student learning. Today's teachers may select teaching strategies from models aimed at increasing student cooperation, achieving mastery, raising expectations, teaching to different learning styles and so on (Arredondo, 1990; Arredondo & Block, 1990; Berliner, 1984; Guskey, 1990; Marzano, Pickering, & Brandt, 1990; Wittrock, 1986). These and other instructional models offer teaching strategies based on current research in self-regulated learning, knowledge acquisition, knowledge change (i.e., accretion, tuning, and restructuring), and on the qualities exhibited by effective learners (Ennis, 1985; Glatthorn & Baron, 1985; Marzano, Pickering, Arredondo, Blackburn, Davis, & Ewy, 1988; McCombs, 1989; Rumelhart & Norman, 1981).

Recent restructuring efforts emphasize the need for staff developers to provide teacher learning opportunities consistent with those factors that enable changed practices (McLaughlin, 1990). The norm of individual growth and development is nurtured by the provision of multiple resources with which teachers can develop skill in the use of new teaching strategies (Joyce, Bennett, & Rolheiser-Bennett, 1990; Rosenholtz, 1985; Scott & Smith, 1987).

However, although much is known about effective instruction, the teaching practices of elementary and secondary teachers have shown considerable resistance to change. For example, an estimated fewer than 13.7% of the nation's teachers consistently use strategies based on current research in their daily lessons (Michael & Arredondo, 1990). One result is reduced efficiency and effectiveness in student learning.

The ubiquity of the computer in the schools has been well-documented (Becker, 1983, 1987; Rucinski, 1991). However, most of the research on the effectiveness of CAI is centered on students from the preschool level to college age (Jones, 1990; Shaw, 1984; Taitt, 1985; Thompson, 1985), or in training situations at the adult level (Willard & Paton, 1990). There is little, if any, research on the effectiveness of CAI materials used in an inservice format. Use of the computer at the inservice level seems to be confined to computer literacy (Thompson & Friske, 1988), integration of the computer in the

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classroom (Riel, 1989), or retraining of teachers for positions as "Computer Learning" teachers (Bitter & Sheets, 1987).

Few software programs have been designed to address the acquisition of effective teaching skills, as evidenced by perusing educational software catalogs. Teaching is one profession experiencing significant change because of advancements in computer technology. For example, *Teacher Magazine* devoted over half of its January 1991 issue to "Teaching with Technology." Present and future teachers need to have an opportunity to develop the skills necessary to fully take advantage of the new technology. Teacher education institutions have an obligation to meet these needs and must provide access to, and instruction on, state of the art computer hardware and software (Bruder, 1989; Rucinski, 1991; Thompson, 1985). As indicated by Edward Fiske, education editor for the New York Times, teacher trainers cannot afford to do less than their utmost in preparing teachers. Technology must enter all levels of education, including computer assisted tutorials and simulations.

In this project, CAI materials, specifically a Level 3 interactive videodisc and computer managing program, have been developed for use as an alternative learning activity for teachers being trained to use thinking in content strategies in their classrooms. It is believed that development of CAI materials for the integration of instructional models will enhance educational practice through increased use of interactive technologies. They will also support research in the teaching and learning process. These materials have the advantage of being available for review when the trainers are not present and for experiencing at times convenient to the teachers.

The Integrative Framework

Educational researchers have advanced an abundance of practices that teachers can use to improve student learning (Marzano, Brandt, Hughes, Jones, Presseisen, Rankin, & Suhor, 1988; McCombs, 1989; Rumelhart & Norman, 1981). They have designed and tested programs which maintain discipline, motivate students, use learning theory, encourage cooperative behavior, teach thinking, and so on. Unfortunately, teachers view many of these programs as disjointed efforts, separate from one another—as bandwagons—each an isolated movement to be used until the next new model comes along. What is needed is a framework to integrate these programs—a tool that willhelp educators see how all the research on teaching and learning is related. With such a framework, teachers will find it easier to recognize the connections between the different instructional models and to select and use appropriate pieces of the research to improve instruction in specific learning situations within their own classrooms.

An integrative framework has recently been developed by a team of writers headed by Robert J. Marzano at the Mid-continent Regional Educational Laboratory (McREL) in Aurora, Colorado. This framework, an instructional model called Dimensions of Learning (DOL) (Marzano, Pickering, Arredondo, Blackburn, Davis, & Ewy, 1989), integrates the past fifteen years of research on teaching and learning, and presents a way of viewing teacher decisions about instructional situations from the perspective of the student. Based on the premise that learning content material requires rigorous thinking about content, this project is a direct outgrowth of efforts by the Association for Supervision and Curriculum Development (ASCD) to develop a comprehensive framework for teaching thinking. This association produced *Dimensions of Thinking: A Framework for Curriculum and Instruction*, (Marzano et al, 1988) and *Tactics for Thinking* (Marzano & Arredondo, 1986). The DOL model was field tested by eighty-five participants from seventeen schools or school districts across sixteen states and two countries.

Developing the CAI Strand—Tutorials and Simulations

Research has shown that computer assisted instruction (CAI) strategies are useful for integrating content knowledge and thinking processes (Kinzer, Sherwood, & Bransford, 1986), and that tutorials are effective in introducing new concepts, rules and simple applications of rules, especially when large amounts of information are presented (Hannafin & Peck, 1988). Simulations have the advantage of not only allowing students to practice and reinforce what was previously learned through multiple executions of the program, it also provides them with the opportunity to explore mislearnings without "real life" consequences (Dennis & Kansky, 1984).

Using CAI tutorials for introducing the concepts and strategies delineated in DOL should provide an effective training situation and also help teachers develop skill and confidence in using CAI approaches with their students (a secondary focus of this research). After initial learning of the DOL strategies, computerized simulations should reinforce procedures the teachers might be expected to follow with students and assist them with teaching decisions, such as when one procedure may be more effective than another (e.g., when semantic webbing might be preferable to the KWL technique [Ogle, 1986]).

The use of computerized tutorials and simulations with the DOL materials provides the advantages of availability and matchingindividual learning preferences. The ready availability of the machine as trainer allows the teacher to access initial training and review whenever she or he desires. The tutorials and simulations are constructed in such a way that a strictly linear path through the program is not the norm, thereby providing a better fit between the learner and instruction. For example, in tutorials, learner responses determine what is seen next as well as whether or not an alternate way of presenting the material is needed. In simulations, the screens seen by the student are determined by decisions she or he makes. In both tutorials and simulations, for example, it should be possible for three different people to have traveled three different paths from the first screen to the last.

In the first phase of this research project, the researchers designed and produced a Level 3 interactive videodisc for use in training K-12 teachers (in all subject areas) to use the DOL framework to integrate the teaching of content material with thinking processes. This production involved coaching teachers in use of the DOL strategies, video taping appropriate use of strategies in classrooms, and programming the computer to manage the taped segments as well as the tutorials and simulations.

History of the Project

During the spring of 1990, the Vice-President for Academic Affairs at Auburn University announced a competition for grants to support the use of technologies in enhancing teaching at the university. Dr. Terrance Rucinski and a colleague, Dr. Bruce Ledford, submitted a successful proposal to produce an interactive videodisc based on DOL. Drs. Rucinski and Ledford would collaborate on the instructional design of the videodisc, Dr. Ledford would direct, tape, and edit the video segments, Dr. Rucinski would provide the computer programming expertise, and Dr. Arredondo-Rucinski would serve as subject-matter consultant for the project.

An assistant principal of one of the area schools, who was also a student in one of Dr. Rucinski's classes, identified two teachers on his staff who might be willing to participate in the project. A faculty member of the College of Education at Auburn University also volunteered after hearing a presentation on the DOL project by Dr. Arredondo-Rucinski. After initial training by Dr. Arredondo-Rucinski, each of the teachers was videotaped presenting either declarative or procedural information to their classes using the strategies they had learned.

Drs. Ledford and Arredondo-Rucinski edited the videotape, Drs. Rucinski and Arredondo-Rucinski wrote the script for voice-overs, and these were recorded by Dr. Ledford with Dr. Rucinski providing the narration. After pressing the check disc, TenCore Producer was used to provide the computer managing program for both the video segments and the CAI tutorials and simulations.

Evaluation of the Project

These CAI materials are being developmentally tested with Auburn University and Valdosta State College graduate students in teacher education classes during the fall and winter quarters of 1991-92. The materials are also being reviewed by an external review panel made up of experts in instructional design, CAI, and thinking skills from Auburn University, Temple University, Sonoma State University, Yale University, the South Carolina Department of Education and the Alabama Department of Education. Two public school practitioners participating in the DOL Project will also be asked to review the materials.

There will be observations of selected classrooms by the researchers. Teachers will be asked to keep a daily journal over a period of three weeks regarding use of the paradigms learned during the training period and their own use of the computer modules. These journals will consist of short answer items with opportunity for elaboration. The object of the evaluation will be to produce "thick descriptions" as identified by Geertz (1973) which will be accomplished through interviews and also using logbooks to gather data. Drs. Arredondo-Rucinski and Rucinski will conduct in-depth "elite" interviews as defined by Dexter (1970). This particular kind of interview involves: "stressing the interviewee's definition of the situation; encouraging the interviewee to structure the account of the situation; and letting the interviewee introduce to a considerable extent his notions of what he regards as relevant" (Dexter, 1970, p. 3).

Through this type of enquiry, it will be possible to ascertain difficulties, both actual and perceived, in integrating and identifying the instructional models and identifying strengths and weaknesses of the CAI materials. Descriptions of the procedures used by the individual teachers with the CAI materials will provide valuable information concerning the effectiveness of these materials. Data on how the CAI materials can best be presented will also be collected through these interviews. Perceptions of merit and worth of both the integrative framework and the CAI materials will also be collected.

Because one of the probable outcomes is increased ability for problem solving in content, classes of students who have teachers who are not participating in the project in the several schools will be matched with the participants. This will be done through interviews with the teachers and administrators of the schools. Students will be given pre and posttests such as the New Jersey Test of Reasoning Skills (Shipman, 1985) and process-oriented criterion referenced tests that may be in place in either the individual school or school district. Scores on the tests will be compared.

Development of these materials for the integration of instructional models will enhance educational practice through increased use ofinteractive technologies. This study will provide new knowledge about the effectiveness of CAI materials in training teachers in an inservice context of teaching student thinking in content. This will also support research in the teaching and learning process. Integration and synthesis of teaching models through the use of interactive technologies will improve teacher decision-making in instructional situations and should improve student learning in content. These computer training materials will aid in the dissemination of research knowledge on theory and practice about teaching and learning through application in the classroom. New perspectives about the use of CAI as an alternative for professional growth and new understanding about student use of thinking skills and processes in content learning will also be gained.

Acknowledgements

This project was supported, in part, by a grant from the office of the Vide-President for Academic Affairs, Auburn University.

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Integrating Technology Usage Across the Curriculum Through Educational Adventure Games

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Abstract

The reopening of a middle school in San Diego, California provided a testing ground for a unique collaborative effort between the school faculty, a university department, and Apple Computer Corporation. With the desire to infuse technology and cultural awareness across the curriculum, an interactive "microworld" game template was developed for student projects. The twelve-week, interdisciplinary project provided teachers the opportunity to learn more about the potential of educational technology, enhanced their collaborative teaching efforts, and motivated their students toward excelling in the learning process. In addition, the project provided students the opportunity to develop computer-based simulations that fostered team work, improved their subject matter skills across the curriculum, and increased their knowledge of the role culture plays in society.

Introduction

In a section of inner-city San Diego, where the student dropout rate is over 25%, an educational technology experiment with culturally diverse students is beginning to show signs of transforming the way students participate in school. The adopted technology system includes more than just hardware and software. It also includes a unique combination of interactions between students, teachers, parents, university faculty, and business leaders.

O'Farrell Community School, located in southeast San Diego, reopened its doors in the Fall of 1990 with no principals, vice-principals, or counselors, and a 7th grade class of 420 students (35% Afro-Americans, 30% Hispanic, 25% Filipinos, 5% Indo Chinese, and 5% Anglo). Rather than implementing the traditional top-down management system of most schools, O'Farrell opted for a site-based management program in which teachers determine the curriculum, counsel the children, and handle all student related problems. Due to this unique combination of teachers, students, and administrative procedures, Apple Computer selected O'Farrell Community School and the Department of Educational Technology at San Diego State University to participate in a program entitled the Christopher Columbus Consortium. Apple's goal for this program was to form partnerships between university and public school entities to apply microcomputer solutions and educational technology strategies to help solve classroom problems. Thirty-two similar partnerships were established throughout the United States. The focus of the San Diego contingent was to provide a tool that would allow students the ability to easily develop computerized instructional programs. To be successful, the developers hypothesized that this program would need to 1) appeal to teachers to insure that its use would be integrated throughout the curriculum, 2) empower each student with the ability to become the creator, designer, and developer of relevant academic materials, and 3) be easy to use and have a strong motivational appeal to the students to sustain their interest. It was determined that the best method to achieve these goals would be to create a HyperCard template that would allow the students to create an interdisciplinary, interactive "microworld" adventure game.

The initial group of school and university faculty who developed the idea of incorporating microworld programs recognized that structuring an entire school's curriculum around a series of games would probably be met with resistance from the faculty, administration, and students. To increase the probability of acceptance, two objectives were established by this group led by Dr. Bernard Dodge, a university instructor and advocate on the development of educational computer games and simulations. First, the faculty at O'Farrell Community School would need to become closely involved in coordinating and guiding the games to insure its pedagogical success. Second, the students would required a simple method by which graphics, text, sound, and movement through a game environment existed.

Integrating technology throughout the curriculum

In 1988, the O'Farrell School of Preforming Arts closed its doors and relocated to a new facility. This left a vacant building in San Diego's inner city that soon became the target of vandalism and other undesirable behavior. Due to its desire to improve upon traditional educational, the San Diego Unified School District decided to reopen O'Farrell in the Fall of 1990 as a restructured school employing a variety of innovative approaches to education. In staffing the facility, the CEO (Chief Educational Officer) and teachers were all chosen for their subject matter knowledge, enthusiasm, dedication, willingness to examine and incorporate innovative ideas, and commitment to excellence by themselves and their students. Top-down administrative policies were abandoned in favor of decisions made by either the individual teacher, one of three "families" of teachers, or the community council, composed of representatives from teachers, staff, parents, and students. All faculty member and students were assigned to one of three school families. Families were further divided into smaller groups of approximately 22 students (the average classroom size). This model not only provided the teachers a stronger voice in how the school would implement the educational process, but provided a collegial atmosphere of working with school families to achieve educational and social goals. The use of technology to enhance education was provided for with the establishment of computer labs, a media center with mass storage and retrieval devices, and a networked computer system for the faculty. Few teachers, however, had taken the time or had the knowledge to implement the theories or techniques of educational technology in their classrooms.

The idea of incorporating a microworld format across the curriculum originated one month after the beginning of the 1990-1991 school year at meetings with the computer teachers at O'Farrell and faculty members from the Department of Educational Technology. After initial details and overall framework of the process were established, the ideas was presented to the school staff. Although few doubted the pedagogical potential of the proposal, concern was expressed by some on their lack of knowledge of the computer hardware and software to be used in developing the microworlds and how they could insure that the time spend by the students would be meaningful. A conditional acceptance of the proposal was agreed upon when it was decided that all teachers would be trained on the hardware and software involved with the project, and that the microworlds would: a) be developed with an interdisciplinary approach to learning, b) incorporate cooperative learning in teams composed of students from various cultural backgrounds, and c) reflect game scenarios that were historically accurate and cultural relevant to the student population.

Teacher training

To insure the integration of the technology across the curriculum, it was imperative that the teachers gain both a conceptual understanding of how technology assists the learning process and the basic skills for using the required hardware and software. Two venues were established to reach these objectives. First, Apple Computer provided the school with a set of computers, a videodisc player and monitor, and accompanying software. Included in the software was the interactive videodisc and CD-ROM program "Macintosh Fundamentals". This self-paced program provides users a variety of activities to become familiar with the computer and peripheral devices, as well as the HyperCard software program.

In addition, six workshops were conducted to 1) help teachers conceptualize how the learning process can be accentuated with technology, 2) provide them the knowledge required to help initiate and develop the microworld adventure games, and 3) become more familiar with the equipment the students would be using in building their microworlds. These workshops were conducted by the school's computer teachers, media center director, and university faculty.

Interdisciplinary approach

From the beginning of the school year, the faculty at O'Farrell had adopted an interdisciplinary approach to learning. Teachers within families meet daily to coordinate their instructional plans and the school's community council identifies and develops six-week thematic units for the entire school population. Both activities help insure coordination of educational topics. The microworld concept presented an additional avenue for this cooperation. It was decided that all subject domains would contribute either to the building of the microworlds or incorporating the findings into their curriculum. Individual subject domain activities included:

• Language Arts:	Story boards and creative writing lessons for the development of the story lines;
• Social Studies:	Historical research on the cultures, artifacts, geography, and societies that became the basis of factual information for the games;
• Science:	Game obstacles dependent on the science of the time (ie. climate, astronomy, biology);
• Mathematics:	Game obstacles dependent on the mathematical concepts relevant to the time and culture (ie. number systems, calendar, measures);
• Computer:	Instruction on template use and entering material into word processors, graphic programs, and HyperCard template;
• Art:	Development of computerized graphics and scanned images;
• Music:	Incorporation of sound effects and traditional music into the games; and
• Physical Ed.	Incorporation of games and sports played from the different time periods.

Cooperative learning

Cooperative learning arrangement were developed by dividing each class of approximately 22 students into 4 teams, each team responsible for developing one quadrant of their microworld. Because each team had approximately 6 students, specific roles were assigned to help reduce redundancy. These roles became game master, map master, graphic master, word master, sound master, and research master.

In addition to their assigned role, each student was also required to develop at least one completed card for the game. This not only helped insure that each student was competent in all skills required to build a *HyperCard* stack, but also provided a sense of ownership of the finished product. This dual role of reliance on the team as well as the ability to reach individual goals fit into the school's thematic units of dependence and independence.

Because the final product was to reflect the contributions of the entire team, students within each team collaborated and cooperated much more freely than in pre-microworld activities. This cooperative learning occurred not only as material was being entered into the computer, but in all classes as the research, story line, obstacles, and game enhancements were being developed.

The cultural scenarios

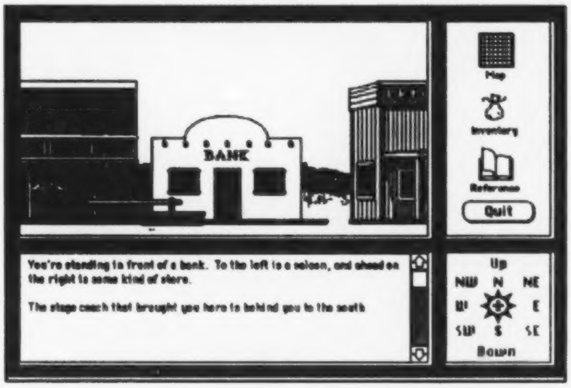
With five major ethnic groups represented in the community, one of the major missions of the school has been to help students become more aware and appreciative of various heritages and cultures. The microworld format provided an ideal platform for this expansion. The community council determined that the microworlds should reflect these representative cultures at important points in their development. Students would then be required to research these cultures to insure that the games depicted historically accurate and cultural relevant information. Five scenarios were eventually chosen for development. All were stated in a manner to entice the students to delve into the culture. For instance, the scenario for the Philippines stated: "You are an advisor to the village chief Lapu-Lapu on Cebu Island. Spanish ships, lead my Magellan, have arrived for the first time in the Philippines. You are to be the negotiator with the Spaniards."

Using the media center's resources, students were able to carry out their initial research into the various cultures and time frame under study. Unfortunately, some areas of research had limited amounts of information available at the school. Trips to the public library, university library, inter-library loan, and modems were used to help provided additional material.

The Microworld template

The students had had some exposure to the Macintosh prior to the project, but no experience with programming. The challenge was to design an authoring system that would allow them to create adventure games without getting bogged down in programming. The tool that resulted is called *Cabrillo*, named after the explorer who was the first European to sight San Diego. *Cabrillo* is a tool for the creation of environments for exploration.

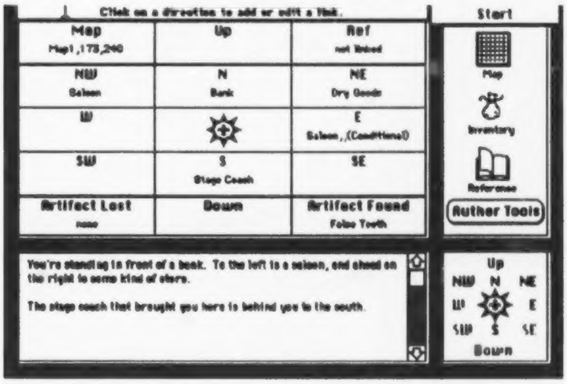
From the player's point of view, *Cabrillo* allows the development of games that are easy to move around in, and that are tied to curriculum by their being grounded in historical reality. Navigation is accomplished by clicking on a compass. Directions that are not open are grayed out, so players don't feel the frustration of trying to "Go North" and having the program tell them "You can't go that way". Maps and a reference manual are available at the click of an icon. Sounds can be attached to any graphic.



You're standing in front of a bank. To the left is a saloon, and ahead on the right is some kind of store.

The stage coach that brought you here is behind you to the south

From a game designer's point of view, *Cabrillo* makes it possible to link screens together by clicking on a template. A designer can create an entire microworld with graphics, sounds, conversing characters, treasures, maps, and a reference guide without ever seeing a line of programming. This opens up the possibility of students creating their own adventures.



Click on a direction to add or edit a link.

Map Map1,173,240	Up	Ref not linked
NW Saloon	N Bank	NE Dry Goods
W		E Saloon,,(Conditional)
SW	S Stage Coach	SE
Artifact Lost none	Down	Artifact Found False Tooth

You're standing in front of a bank. To the left is a saloon, and ahead on the right is some kind of store.

The stage coach that brought you here is behind you to the south.

Conclusions

At the conclusion of the 12 week project, summative evaluations were conducted by graduate students in the Educational Technology Department. Observations and interviews with the school's faculty identified numerous areas where the incorporation of technology provided either direct or indirect improvements in the educational system. Teachers cited that cooperation both within and across families was improved, there was an expansion and integration of technology into the curriculum, and a higher level of cooperative learning, research skills, and higher level thinking skills of the student population was reached. The teachers were also impressed with the students acquisition of facts and concepts of the cultures under study. One hesitancy expressed was the trade-off of time from the traditional curriculum in exchange for developing the microworlds.

Students also cited numerous positive influences from working with the microworld templates. Most notable in the interviews were their comments on increased motivation and excitement that the games provided as they worked with this new curriculum. Observations revealed enhanced team work as the students assigned roles for the production, discussed variables in setting up routes and obstacles as players moved through their world, and relied on each other to complete their quadrant within the allocated time. The exposure to the varied technology of computers, scanners, telecommunications, electronic databases, and audio equipment all contributed not only to the student's development of cognitive skills applicable for future employment, but also contributed to a profound impact on their attitudes of self-esteem and confidence.

The question of how exportable the microworlds approach is to other schools is not yet answered. Massive amounts of technology are not required. What is needed, however, is a staff willing to implement innovative ideas and work closely together. The faculty at O'Farrell voted to incorporate the microworld concept again during the 1991-1992 school year.

Acknowledgements

Support for the development and use of the Microworlds Adventure Template was made possible by an equipment and training grant by Apple Computer. Dr. Patrick Harrison coordinated the grant with San Diego State University, O'Farrell Community School, and Apple Computer. Kathryn Bloomer and Gregory Mandley conducted the summative evaluation.
Dr. Bernard Dodge developed Cabrillo. *Instrumental to building the adventure games using* Cabrillo *were CEO Dr. Bob Stein, computer teachers Roland Garcia, George Muñoz and Laura Parks-Sierra, and the faculty, staff, and students of O'Farrell Community School.*

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Interactive Video and the Classroom Management Skills of Preservice Teachers

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Abstract

The purpose of this study was to investigate the relative effectiveness of interactive videodisc simulations and comparable text-based simulations in facilitating the classroom management decisions made by preservice and inservice teachers. Similar interactive simulations of classroom discipline situations were used, one delivered via interactive video and the second via a text-based computer program. Subjects (64 preservice, 44 inservice) were assigned to either interactive video or interactive text simulations. Data obtained represented the number of resolving decisions minus the number of confrontational decisions. ANOVA procedures revealed that the preservice-text group made significantly fewer resolving decisions than other groups. These findings suggest that the increased degree of situational realism provided by the interactive video format enabled preservice teachers to make management decisions similar to those of experienced teachers.

Introduction

Computer driven simulations have been used for a number of years as a pedagogic technique for providing students with realistic experiences in which they can apply problem solving and decision making skills. Simulated classroom experiences have similarly been used to allow pre-service teachers to confront some of the tasks and situations they will face in the actual classroom environment. Cruickshank (1969) developed an SRA produced simulated school in which he used filmstrips, records, films and situation cards to create a scenario in which the role of a fictitious sixth grade teacher, Pat Taylor, was enacted by participants. Cruickshank (1986) later suggested that "concrete-real" instructional methods such as student teaching could be made more effective if they were preceded by "concrete-modeled" experiences such as simulations. Research by Kersh (1963); Smith (1986); and Strang, Kauffman, Badt, Murphy, and Loper (1987) all emphasized the efficacy of realistic classroom simulations. Practice has further demonstrated the popularity and power of this approach to preservice teacher education.

More recently, the advent of the laser videodisc and the concomitant development of interactive video models of computer based instruction have made possible the development of fairly sophisticated, interactive learning tools (Dalton, 1986; Dalton & Hannafin, 1987). It is widely believed that the use of interactivevideodisc simulation in teacher training could offer the possibility of learning new techniques in a number of important skill areas while in a controlled environment. This assumption is based on the effects of more traditional simulation methods that are used to develop important pedagogic skills for both preservice and inservice teachers (i.e., practicums, microteaching, observations, workshops, etc.). Interactive video makes it possible to increase the amount of active simulation teachers can experience while providing for greater control over the nature of that experience. It is generally held that an increase in the relative degree of situational realism will automatically result in a corresponding increase in learning. Research on this issue is, however, conflicting and essentially unresolved.

To date there has been limited application of this technology in the training of teachers. Those studies that have been reported have produced positive results (Volker, Gehler, Howlett, & Twetten, 1986; Goldman & Barron, 1990). The application of interactive video to the presentation of classroom management skills, and in particular, to discipline has not been addressed to any great extent. One such project, entitled *Critical Incidents in Discipline*, was developed at Kent State University by Evans, Cupp and Kinsvatter (1987). This interactive videodisc program was designed to present three classroom discipline situations from the viewpoint of the classroom teacher. Teachers or preservice teachers may then interact with the various situations, making what they deem are the appropriate teacher's decisions to each of the simulated discipline problems. As with other interactive video simulations, students are branched through a variety of video sequences that present the probable consequences of their decisions. Little data is available however, regarding the relative value or effectiveness of this simulation as an instructional tool, although Berry and Mull (1990) employed these materials in a preliminary study to assess some effects of interactive video simulations on preservice teachers. Data indicated that interactive video simulations produce substantially different decisions than do text-based materials. One obvious benefit of such a program would appear to be the greater involvement of the learner due to the more realistic presentation of the live video sequences. Such realistic interaction has generally not been possible in previous simulations used for teacher training. It should be noted however, that this program is intended as a discussion provoking device rather than as a direct instructional tool. For this reason, the episodes presented do not necessarily present "right" or "wrong" solutions, but rather different possible alternatives. Some branches emphasize defusing the situation, others, emphasize more confrontational choices.

Purpose of the Study

The purposes of this study were twofold: first, to investigate the relative effectiveness of an interactive videodisc simulation as opposed to a comparable text-based simulation or case study, suchas those presented in many instructional texts; and second, to compare the classroom management decisions made by preservice teachers with those made by inservice teachers.

The following research questions were formulated:

1. Do preservice teachers make more successful discipline related decisions when interacting with a realistic interactive video-based simulation than do preservice teachers interacting with a non-video augmented simulation?
2. Are the types of management strategies employed by preservice teachers using an interactive video-based simulation similar to those employed by inservice teachers?

Method

To address these research questions, a computer-based, text simulation was developed using the dialogue scripts employed in the original videodisc version of *Critical Incidents in Discipline* (Evans et al., 1987). This text-based simulation incorporated all of the branching strategies used in the original, but simply presented the dialogue and described the action occurring in each scene. Such a presentation retained all of the content and information, but did not present the "live" effect of interactive video.

The interactive videodisc program was programmed in HyperCard and was presented via an Apple Macintosh SE computer linked to a Pioneer LD-V4200 videodisc player. The interactive text program was also programmed in HyperCard and was run on the Macintosh computer.

Participants in the study were 64 preservice teachers enrolled in a teacher development methods course and 44 practicing, inservice teachers. None of the preservice teachers had any formal classroom teaching experience and their ages ranged from 20 to 51, with the mean age of approximately 22. The mean number of years teaching experience of the inservice group was 8 years, with a mean age of approximately 33. All participants were volunteers.

The *Critical Incidents in Discipline* simulation consists of three classroom discipline situations: a student who is resisting taking an examination, a fight in the corridor, and an unruly study hall. As each scenario unfolds, the presentation pauses and the "teacher" chooses what to do next. Based upon this decision, the program branches to the most likely consequences of that decision and the "teacher" is again asked to make a new decision. The decision choices available consist of some that are confrontational to varying degrees, some that are neutral or do not contribute to a resolution of the problem, and others that represent defusing or resolving teacher actions. At each decision point, the subject must make a decision and deal with the consequences. In some cases the incorrect decisions make the situation worse and in others, the problem is resolved. Resolution is generally dependent upon theteacher's ability to defuse and discuss the problem rather than to become defensive or authoritarian. The total time required to complete the three incidents was approximately twenty minutes. Subjects worked individually with their respective programs and were encouraged to take as much time as necessary to think through their responses.

Results

Each participant's choice of action was recorded at the critical decision points. In accordance with the prior classroom instruction that emphasized diffusion over confrontation, a confrontational response was scored as a -1, a neutral, non-resolving choice was scored 0 and a defusing or resolving decision was rated +1. Subject total scores for each of the three incidents were summed to provide a total decision score. Each score was subsequently adjusted by a value of +4 to eliminate negative values. Mean adjusted total decision scores for each experimental group are presented in Table 1.

Table 1
Total Decision Score Means and Standard Deviations for each Experimental Group (adjusted)

Group	*N*	*M*	*SD*
Preservice			
interactive video	37	6.00	2.26
interactive text	27	3.85	1.85
Inservice			
interactive video	24	5.17	2.18
interactive text	20	5.35	1.76

A 2 x 2 factorial research design was employed to compare the two presentation formats (i.e., interactive video, interactive text) at each of two levels of teaching experience (i.e., preservice, inservice). Analysis of the data obtained, via ANOVA procedures, produced a significant interaction ($F(1, 104) = 4.85$, $p = 029$), and a significant main effect for treatment ($F(1, 104) = 9.52$, $p = .002$). The main effect for teaching experience was not significant ($F(1, 104) = 2.21$, $p = .141$). Because a significant interaction was present, t tests were conducted on all pairs of means. The analysis indicated no significant differences between the treatments for inservice teachers or between inservice and preservice teachers using the interactive video format. Preservice students who received the text format scored significantly lower than subjects in all other groups in their ability to resolve the discipline situations successfully.

Discussion

The first research question is answered in the affirmative by the fact that preservice teachers who interacted with the video format simulation scored significantly higher than did those who received the text-based program. Higher scores in the simulation decision making indicate that those subjects employed more defusing or resolving strategies and were consequently more often able to bring the incidents to satisfactory conclusions.

Regarding the second research question, the finding that preservice teachers receiving the interactive video format simulation did not differ significantly from inservice teachers under either treatment strongly suggests that the use of realistic, video materials provides the preservice teacher with additional, more accurate information upon which to base management decisions. Those preservice teachers who did not receive video-based materials appear not to have been able to "read" enough information from the situation to make as effective decisions. This would imply that certain, non-verbal, visual or, situational information is used by the teacher in formulating decisions regarding classroom discipline. The lack of significant differences between groups of inservice teachers may be related to the fact that these individuals have developed, over time, a repertoire of schema related to how one deals with specific situations and consequently they have less need for direct, realistic experiences. It is not clear however, what information is extracted from the situation for use in making decisions.

Greater understanding and interpretation of the results may be drawn from an opinion survey requested of all participants upon completion of the experiment. Participant responses emphasized the role of context and "seeing" the actual events in making their decisions. The text version was seen as being unreal and contrived. Opinions of the two versions by the respective groups were generally more positive toward the interactive video treatment on the grounds that it allowed students to feel more a part of the situation and more in control. They also indicated a greater sense of being able to "monitor" what was going on. This may have occurred as a result of the learner's being able to read the additional visual and verbal cues presented only by the video presentation. As could be expected, the inservice groups frequently referred to prior classroom experiences as providing models for dealing with the decisions presented in the simulations.

Findings such as those presented here strongly support the effectiveness of interactive video for presenting more realistic classroom experiences to preservice teachers. They fall short however, in that they do not identify those factors that are responsible for this effect. Further research should address and identify those visual or nonverbal design components inherent in the more realistic, video presentation that may assist the teacher in developing a more complete representation of the situation. Additionally, research needs to focus on developing anunderstanding of how experienced teachers analyze discipline situations and apply strategies so as to enable preservice teachers to model the appropriate techniques. Both of these needs are predicated on a more detailed knowledge of the cognitive processes that are employed by both inservice, experienced teachers and by preservice or beginning teachers in analyzing a given situation.

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